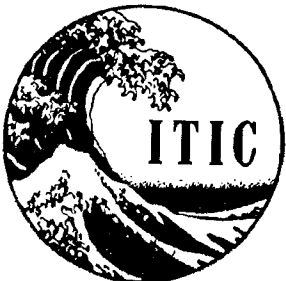


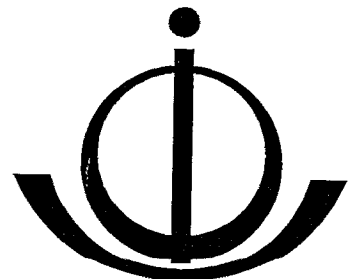


TSUNAMI NEWSLETTER

JULY 1990
VOLUME XXIII, No. 1



International
Tsunami
Information
Center



Box 50027
Honolulu, HI 96850-4993
Telephone: (808) 541-1658
FAX: (808) 541-1678

UNESCO
INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
COMMISSION OCEANOGRAPHIQUE INTERGOUVERNEMENTALE
COMISION OCEANOGRAFICA INTERGOVERNAMENTAL
МЕЖПРАВИТЕЛЬСТВЕННАЯ ОКЕАНОГРАФИЧЕСКАЯ КОМИССИЯ
اللجنة الدولية الحكومية لعلوم المحيطات

INTERNATIONAL TSUNAMI INFORMATION CENTER

Box 50027, Honolulu, Hawaii 96850-4993

Telephone: (808) 541-1658

Fax: (808) 541-1678

Director: Dr. George Pararas-Carayannis

TSUNAMI NEWSLETTER is published by the International Tsunami Information Center to bring news and information to scientists, engineers, educators, community protection agencies, and governments throughout the world.

We welcome contributions from our readers.

The International Tsunami Information Center (ITIC) is maintained by the U.S. National Oceanic and Atmospheric Administration (NOAA) for the Intergovernmental Oceanographic Commission (IOC). The Center's mission is to mitigate the effects of tsunamis throughout the Pacific.

Member States

Present membership of the IOC International Coordination Group for the Tsunami Warning System in the Pacific (ITSU) comprises of the following States:

AUSTRALIA

CANADA

CHILE

CHINA

COLOMBIA

COOK ISLANDS

DEMOCRATIC PEOPLE'S
REPUBLIC OF KOREA

ECUADOR

FIJI

FRANCE

GUATEMALA

INDONESIA

JAPAN

MEXICO

NEW ZEALAND

PERU

PHILIPPINES

REPUBLIC OF KOREA

SINGAPORE

THAILAND

UNION OF SOVIET
SOCIALIST REPUBLICS

UNITED KINGDOM (HONG KONG)

UNITED STATES OF AMERICA

WESTERN SAMOA

– NEWS EVENTS –

INTERNATIONAL DECADE FOR NATURAL DISASTER REDUCTION PROCLAIMED

The 85th United Nations General Assembly plenary meeting adopted the Resolution which officially proclaimed the commencement of the International Decade for Natural Disaster Reduction on 1 January, 1990.

All governments have been called upon to implement certain measures, including:

- The impact of natural disasters on health care
- Increasing public awareness of damage risk probabilities and the significance of preparedness
- Establishing national committees to achieve the decade's goals

The United Nations has designated that the second Wednesday of October as International Natural Disaster Reduction Day. In 1990, this will fall on 10 October.

MARIANA TRENCH TSUNAMI 5 APRIL 1990

Tsunami history was made on 5 April 1990 when an earthquake in the Mariana Trench, 70 nautical miles East of Saipan generated the first recorded tsunami from this region. The earthquake had an M_s magnitude of 7.4 and its epicenter was located at 15.4 N, 147.3 W. It occurred at 2113 Z. Initial news reports of 3-4 meter waves at Tinian and Saipan were extremely exaggerated. Nonetheless, tsunami waves measuring up to 24 centimeters were recorded in Japan and in Hawaii. A more complete tsunami report is provided in the Pacific Tsunami Warning Center section of this Newsletter.

A TSUNAMI DISTURBANCE OBSERVED IN HONG KONG

Mr. Wai-choi Lee, Director of the Royal Observatory, Hong Kong, has documented the first tsunami generated by an earthquake in the South China Sea observed in Hong Kong. It was generated by an earthquake measuring 5.3 on the Richter scale which occurred on June 24, 1988, in the Philippines at the northern tip of Luzon, 60 km northeast of the city of Laoag, at about 10 a.m.

Four hours and twenty minutes later, the tsunami disturbance set up by the earthquake reached the South China coast after crossing the northern part of the South China Sea. In Hong Kong, at Quarry Bay Station the tsunami arrived at 0625 UTC. Its maximum wave height was 0.65 m. At Tai Po Kau station it arrived at the same time but its height was greater, being 1.03 m. The much higher wave at Tai Po Kau was probably because of the shallower water and the channeling effect of the Tolo Harbour.

The last time a tsunami was observed in Hong Kong was after the earthquake in Chile of May 22, 1960.

For more details of this event, please contact Mr. Lee at the Royal Observatory, Nathan Road, Kowloon, Hong Kong.

EARTHQUAKE 5.9 KILLS 120 IN INDONESIA

An earthquake registering 5.9 on the Richter scale struck Indonesia's West Irian province on 1 August 1989. Landslides buried two villages killing 120 people and injuring 60. A second earthquake struck the same area the following month on 4 September 1989, flattening wooden houses.

NEW ZEALAND'S TWO ISLANDS JOLTED BY EARTHQUAKES

On 8 August 1989, an earthquake measuring 5.6 on the Richter scale occurred between the North and South Islands. Damage to property was sustained. On 19 February 1990, an earthquake measuring 6.4 on the Richter scale struck 110 miles northeast of Wellington causing power blackouts and minor damage on the North Island.

2 KILLED IN ETHIOPIAN EARTHQUAKE

An earthquake measuring 6.3 on the Richter scale struck Ethiopia on 20 August 1989, 400 km northeast of Addis Ababa. Casualties were 2 dead and 2 injured. Damage was reported in Djibouti and East Ethiopia where landslides occurred.

2 EARTHQUAKES JOLT CHINA

An earthquake registering 6.2 on the Richter scale struck Sichuan Province, southwest China, on 22 September 1989, injuring 54 people and destroying over 4,000 homes. Earthquakes measuring 5.2 and 5.4 on the Richter scale struck Sichuan Province on 20 November 1989. 3 people died and 5 were injured.

EARTHQUAKE AND SEVERE AFTERSHOCKS KILL 29 IN NORTHERN CHINA

On 18 October 1989, an earthquake measuring 5.3 on the Richter scale with numerous aftershocks jolted villages in the Shanxi-Hebei border area killing 29, injuring 150 and leaving 50,000 homeless.

SEVERE EARTHQUAKE HITS THE SOLOMONS

A strong earthquake measuring 7.2 on the

Richter scale struck the Solomon Islands on 27 October 1989. There were no reports of injury or damage.

NORTHERN ALGERIAN EARTHQUAKE KILLS 30

An earthquake measuring 6.0 on the Richter scale hit northern Algeria on 29 October 1989, killing 30 and injuring 245. The earthquake was centered 25 km west of Algiers.

EARTHQUAKE 6.0 RECORDED OFF JAPAN

On 5 November 1989, an earthquake measuring 6.0 on the Richter scale occurred 93 miles off the coast of Sanriku, 340 miles northeast of Tokyo. There were no casualties or damage.

IRAN HIT BY EARTHQUAKE

On 20 November 1989, an earthquake registering 6.0 on the Richter scale struck southeastern Iran. At least 3 people were killed and 45 injured.

EARTHQUAKE OFF THE PHILIPPINES KILLS 2

On 15 December 1989, an earthquake measuring 7.3 on the Richter scale occurred off the coast of Mindanao. 2 people were killed and many injured.

5.4 EARTHQUAKE CAUSES SEVERE DAMAGE IN AUSTRALIA

At least 11 died and more than 120 were injured as a result of an earthquake measuring 5.4 on the Richter scale which struck Newcastle, 140 km north of Sydney, on 27 December 1989.

This is the first earthquake in recorded his-

tory to produce fatalities in Australia.

NO DAMAGE FROM PAPUA NEW GUINEA EARTHQUAKE

No damage was reported from an earthquake registering 6.7 on the Richter scale which occurred 670 km north of Port Moresby on 30 December 1989.

EARTHQUAKE SHAKES TAIWAN

An earthquake measuring 5.8 on the Richter scale jolted eastern Taiwan on 15 January 1990. The epicenter was about 20 miles north of the city of Hualien. No casualties or serious damage was reported.

NORTH COAST OF CALIFORNIA ROCKED BY EARTHQUAKES

On 16 January 1990, an earthquake measuring 5.1 on the Richter scale struck 50 miles south of Eureka. There were no reports of damage or injuries. This was the second large earthquake in Northern California in the last four months. On October 17, 1989 a large earthquake with a magnitude 7.1 struck south of the San Francisco area causing numerous casualties and severe property damage.

EARTHQUAKE 6.9 INJURES 22 IN THE PHILIPPINES

On 8 February 1990, an earthquake measuring 6.9 on the Richter scale was centered near Camiguin Island, southeast of Manila. At least 22 people were injured in the earthquake, the most severe in nearly 50 years.

EARTHQUAKES NEAR VANUATU

The first earthquake occurred on 19 February 1990 and measured 6.8 on the Richter scale. It shook the Vanuatu Islands. The epicenter was about 1,300 miles northeast of

Brisbane. On March 5, 1990, an earthquake measuring 7.1 on the Richter scale occurred near Vanuatu in the South Pacific at 11:49 a.m. The epicenter was about 1,400 miles northeast of Sydney.

MORE EARTHQUAKES HIT CHINA

According to the Chinese State Seismology Bureau, on April 26, 1990 a powerful earthquake, with its epicenter 900 miles southwest of Beijing, killed 115 people and demolished more than a thousand homes in a remote area of central China. The quake was felt in the provincial capital of Xining, 70 miles to the northeast of the epicenter, and in the city of Lanzhou, 185 miles to the east.

Another 160 people were injured in the tremor and aftershocks that struck the Hainan Tibetan Autonomous Prefecture of Qinghai province. More than 600 homes were destroyed by aftershocks — some of them as strong as 6 on the Richter scale.

The earthquake measured 6.9 on the Richter scale and it was the worst in China since November 1988 when a quake measuring 7.6 on the Richter scale killed 730 people in the Southwest province of Sichuan.

5000 people were reported homeless by the tremor.

The far western Chinese province of Xinjiang was hit earlier in the month, on April 19, by a quake measuring 6.4. About 1,300 homes were damaged and two people injured from this event.

MEXICO INVITES XIII SESSION OF ICG/ITSU

Dr. Mario Martinez Garcia, General Director of the Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (CICESE) in Baja California, on behalf of the Mexican Government, extended an invita-

tion to the Secretary IOC, Dr. G. Kullenberg and to ICG/ITSU Chairman, Mr. R. Hagemeyer to hold the XIII session of IOC-ICG/ITSU in Mexico at the end of 1991. The Secretary of IOC has written to CICESE inquiring about the proposed place and favorable time during the second half of 1991 for holding the above session. When this information is received, ITSU Member States will be informed and based on their response a final decision will be made.

**INTERNATIONAL CONFERENCE ON
GLOBAL WARMING –
A CALL FOR
INTERNATIONAL COORDINATION
9-12 APRIL 1990,
CHICAGO, ILLINOIS**

An international conference, Global Warming-A Call for International Coordination, was held in Chicago from 9-12 April 1990. Among the topics presented were Scientific and Policy Issues Facing Governments in Transnational Environmental Problems (Global Warming, Water Shortage, Floods, and Acid Rain); The Future of Modern Industrial Technologies and Their Utilization (Energy, Transportation, Mineral and Material); and Greenhouse Gas Production in Nations and Regions. It was sponsored by SUPCON International and the World Resource Review. For information, contact SUPCON International, U.S. Headquarters, 1 Heritage Plaza, Woodridge, IL 60517.

**XV EUROPEAN GEOPHYSICAL
SOCIETY GENERAL ASSEMBLY
23-27 APRIL 1990,
COPENHAGEN, DENMARK**

Within the framework of the XV European Geophysical Society General Assembly held at Copenhagen, Denmark, from 23-27 April, a workshop entitled *"Tsunami Sources Around*

Europe" was held. For information, contact:

EGS office
Postfach 49
3411 Katlenburg-Lindau
Federal Republic of Germany.

**FOURTH U.S. NATIONAL
CONFERENCE ON
EARTHQUAKE ENGINEERING
20-24 MAY 1990, EARTHQUAKE
ENGINEERING INSTITUTE
PALM SPRINGS, CALIFORNIA**

The Fourth U.S. National Conference on Earthquake Engineering was held at the Earthquake Engineering Institute, Palm Springs, California, from 20-24 May 1990. For information, contact:

Dee Czaja
4NCEE, Department of Civil Engineering
University of California-Irvine
Irvine, CA 92717
Telephone: (714) 856-8693.

**FOURTEENTH INTERNATIONAL
TSUNAMI SYMPOSIUM,
NOVOSIBIRSK, USSR,
JULY 31-AUGUST 3, 1989**

*E.N. Bernard, National Oceanic and
Atmospheric Administration
G.T. Hebenstreit, Science Applications
International Corporation*

Introduction

The fourteenth IUGG-sponsored Tsunami Symposium was held July 31 through August 3, 1989 in Novosibirsk, USSR. Sixty-five scientist from 13 countries gathered to discuss recent advances in tsunami research. The symposium was a great success due to the enthusiasm of the participants, the quality of research presented and the great organization provided by the Soviet hosts. Teams of dedi-

cated workers, under the fine leadership of Academician A.S. Alexseev and Dr. V.K. Gusiakov, blended social and scientific activities in a memorable fashion. Besides the hospitality, one other important fact will also be associated with the location of the symposium - it represented the place on earth farthest from any ocean! So it may be stated that tsunami scientists practice safe meeting attendance.

The 62 presentations of the symposium were divided into six areas of research: generation (7), propagation (12), coastal effects (10), observations (11), seismic and tectonics (10), and hazard mitigation (12). A summary of the research presented was prepared by each session chairman and is provided below. A poster session was held one evening during which 14 additional reports were given (see Figure 1 for example). A trend toward more applied interdisciplinary research was evident in the research presented. This small community of scientists continues to conduct interdisciplinary research in close collaboration, which makes the transfer of new knowledge rapid. These scientists are acutely aware of the importance of their research and clearly demonstrated relevance to the mitigation of tsunami hazard.

Generation

The first sessions of this symposium discussed progress in our attempts to understand the mechanism of tsunami generation and the form of tsunami waves near the source. V.K. Gusiakov examined techniques currently employed at the Novosibirsk Computing Center to model generations using Ward's coupled model. S.I. Iwasaki examined tsunami generation by submarine landslides. He pointed out that, although landslides have caused a number of tsunamis, we know very little about the landslide process itself, and thus have a difficult time building models.

B. Levin and S. Soloviev described labora-

tory experiments of wave generation by bottom vibrations at seismic frequencies. Their work suggests that the distinctive surface wave patterns developed at the source should be readily observable by airborne sensors.

I. Selezov described analytical investigation of the effect of source rise-time on the initial waves. He has found that longer rise times decrease energy imported to the waves, and that as ocean depth of the source increases the effects of the compressibility of the sea water increase. S. Dotsenko and B. Sergeevsky examined the dependence of dispersive and non-dispersive effects on the rise-time and source geometry. They found that dispersive effects can be significant for small, axisymmetric sources with rapid rise time. They also found that increased rise times decrease both leading wave energy and total wave energy. A. Marchuk and V. Titov discussed the concept of wave focusing and a means of interpreting differences in wave height near the source.

It is clear that these reported efforts show both significant progress in our understanding of generation as well as the limits of that understanding. In particular, we can see the need for more detailed examination of the details of the process in terms of wavelengths of generated waves, not just total energy. Such studies will not only enhance our understanding of the process but will allow for improved numerical models and improved understanding of the earthquake source themselves.

Tsunami Propagation

Professor N. Shuto led off the session on propagation with an invited paper describing the state of the art of tsunami modeling and future directions for modeling. He discussed current aspects of the generation and problems and ways in which numerical models deal with them. He discussed four areas that

pose strong challenges for the near future: (1) the need for better observation data, (2) the uses of higher order equations, (3) the need to examine secondary effects such as fire and floating debris, and (4) innovative uses for computer graphics.

Drs. V. Titov, N. Voltzinger, and K. Klevanny discussed various aspects of numerical grid size and generation. Although both papers conveyed much information, it was not clear why the methods described are superior to existing techniques.

Dr. M. Zheleznyak discussed the importance of non-linear and dispersive effects in studying coastal propagation. He indicated that these considerations would be important in examining secondary effects as discussed earlier by Shuto.

Two papers (I. Molotkov and Y. Egorov) discussed coastal propagation modeling. One discussed results in terms of solitary wave considerations, while the other discussed analytical methods for strongly non-linear waves.

V. Bakhteev discussed model studies of wave trapping around islands in the Kuril chain, and how such trapping affects tsunami propagation. G. Kang and J. Ryom discussed an empirical model to allow computation of probable tsunami heights on the Korean coast. Y. Shokin described the development and production of travel time charts for use in the international tsunami warning systems.

A. Gurevich discussed the ways in which hydroacoustic waves generated by tsunamis could be generated and could be used to assist in tsunami warnings. Their findings seem to agree with those of B. Levin and S. Soloviev, which indicated that wave patterns during generation should be visible on the surface.

Finally, F. Inamura showed how improved

renditions of wave and wave-induced currents could aid in protecting local aquaculture from tsunamis. It seems clear from these papers that questions of open-ocean propagation have rightly become secondary to examinations of waves in the nearshore environment.

Coastal Effects

The paper by V. Yakovlev and A. Pyatetsky reported on the construction of solutions to problems of the diffraction effect observed when single and cnoidal waves interact with cylindrical and conical structures. The authors studied the steepness effect of climbing waves on wave loads affecting both single and multiple obstacles of a complicated shape.

The investigation of the tsunami wave run-up on a beach was given by E. Pelinovsky, V. Golinko and P. Mazova. Control parameter of the problem (in the case of ideal fluid) are the bottom sloping angle and the breaking parameter. Solution of the one-dimensional nonlinear problem was obtained using the Carrier-Greenspan transformations. A stage-by-stage approach for finding run-up characteristics was formulated: the linear calculation of shoreline oscillations and the subsequent nonlinear transformation of the solution according to the Riemann method. A simple way to find the breaking parameter for a wave of arbitrary shape was described. Examples of the wave run-up calculation in the case of pulse perturbation on shelves of various geometries were given, and the influences of dissipation on run-up characteristics was discussed.

H. Yeh (presented by C. Synolakis) discussed the behavior of a single bore propagating into quiescent water. He found that the speed of bore propagation on a uniformly sloping beach decreased faster than the inviscid shallow water wave predictions; that

"bore collapse," as predicted from theory, resulted from a momentum exchange with water pushed ahead of the bore; that, contrary to theoretical predictions, pressure must play a role in the early stage of run-up motion; that the maximum run-up height can be predicted by inviscid theory using a reduced value of the initial run-up velocity; that a single incident bore generates two successive run-up motions; and that the behavior of an undular bore is different from that of a fully-developed bore.

V. Davletshin described large-scale studies aimed at comparing experimental and theoretical data concerning long-wave splash and pressure on walls. He presented measurements of splashes and pressures due to solitary waves, bores, and breaking waves. He found that the scale effect for the pressure of breaking waves and bores is due to aeration. The boundaries of the effect were determined and essential formulas were presented.

T. Sokolowski discussed the automated Alaskan Tsunami Warning System, which contains an advance automatic and interactive computer processing system to provide immediate warnings in Alaska, Canada, and the west coast of the USA. This system has now been instrumental in producing six warnings during the past two years. All of these warnings were issued 8 - 14 minutes after the earthquake, attesting to the effectiveness of the system.

Y. Tsuji demonstrated that tsunamis propagating into rivers could be explained using the theory of an undular bore. Using data from the 1983 tsunami, his theory explained 90% of the observed behavior. K. Fujima and N. Shuto revealed a technique for approximating Manning's friction law in numerical experiments that would save computational cost. H. Watanabe showed that tsunami impact along Japan's coastline depended on

the depth of water at the source. Y. Aleshkov gave a theoretical discussion of long waves interacting with cylindrical objects. His approach used a local coordinate system to determine the load on the obstacle. Mironov's theoretical presentation concerning wave impact on objects of a curvilinear shape advanced a coordinate transformation technique to estimate loading forces. From this session, it is again clear that emphasis is increasingly being placed on how waves interact with the shore and with obstacles on the shore.

Seismics and Tectonics

Under the session on Seismics and Tectonics, nine very interesting papers were presented. A Ivashchenko gave a paper entitled "On Modern Seismic Activity and Tsunami Threat near the Kuril Islands," in which he outlined the threat of tsunamis in the USSR, primarily along the Pacific coast of the Kuril Islands and Kamchatka. He discussed the variance of long-term predictions of large tsunamigenic earthquakes in the region.

A.V. Vikulin, in his presentation entitled "*Migration of the largest earthquake sources across the Nankai Trench*," discussed the source mechanisms of tsunamigenic earthquakes in the Nankai Trench region and forecasted the occurrence of future events. K. Satake presented the results of a novel study undertaken to reconstruct source parameters and displacements from mareographic recordings of tsunamis. This technique is a much more sophisticated and insightful approach to the inverse tsunami problem than has previously been undertaken.

A. Zakhorova presented a joint paper (with O.Starovoit and L.Chepkunas) which described a study of data obtained from broad-band seismograms and focal plane solutions as they relate to tsunami generation.

D. Reymond presented a method for rapidly determining seismic movement as an indication of tsunami potential. This method was developed using the French Polynesia seismic network. V. Ivanov explained an analysis of seismic and tsunami data to infer earthquake source features. T. Zheleznyak described observations of a unique impulse wave recorded by a very long period (240 sec) seismometer during earthquakes that generate tsunamis. Much discussion about the response characteristics of the seismometer followed the presentation since this phenomenon has not been previously measured.

A. Poplavsky and N. Konstantinova presented their criteria for issuing regional tsunami warnings in the Kuril Islands. The research results of geophysical survey methods used to install tsunami recorders in the Sea of Japan were presented by P. Kaplin. This session served to underscore both the gap in our understanding of source mechanisms, and the usefulness of tsunami data in examining seismic problems.

Tsunami Observations

M. Okada considered a new method for correcting a waveform deformed by non-linear tide gauge response. This numerical method, based on a simple statistical hypothesis, gave an estimate of the waveform outside the tidewall by correcting the tide gauge records. Y. Shokin, L. Chubarov, and K. Simonov discussed an approach to a local tsunami warning system, and some examples of applied computational experiments were considered. For some areas it was shown that, on the basis of computational experiments, one can reduce the number of false alarms. K. Abe developed a new procedure for identifying reflected waves and explained how they could be clearly observed. This approach uses a simplified model approximating the real wave profile by a three-step function. P. Kovalyov, A. Rabinovich, and G. Shevchenko pre-

sented a description of long-wave observations on the northwestern shelf of Kamchatka in the tsunami frequency range. Simultaneous measurements of atmospheric pressure fluctuations were made and small coherence between long waves in the ocean and atmospheric pressure fluctuations was found. Examination of sea activity showed that wind waves and swell are the main sources of background energy in the tsunami frequency band.

A. Rabinovich and G. Shevchenko discussed the problem of estimating extremal sea levels, an important consideration for construction of nuclear power stations and other expensive structures in the coastal zone. The proposed method is based on the analysis of tides, storm surges, and tsunamis, and the calculation of probability densities for each component. The joint distribution of sea level and the return period are computed. This method was used for estimation of maximal sea levels near the northeastern coast of Sakhalin Island.

J. Belokon discussed a nontraditional method of detecting long waves by examining the perturbation of the vertical component of the geomagnetic field induced by tsunami waves. He found this component to be intensified in the region of rapid variation of wave velocity. This variation can be measured on the continental shelf and used to examine both tsunami data and seismic and geophysical data.

K. Minoura and S. Nakaya examined columnar samples of coastal sediment deposits to detect traces of ancient tsunamis. They sampled Lake Jusan, on the Tsugaru Peninsula, and the Sendai Plain of Northeastern Japan. The results of sedimentological and geochemical studies of the samples showed that layers almost coincided with historical ages of tsunamis recorded on ancient

documents. This method is quite interesting and worthy of further study. H. Murakami, T. Shimada, and Y. Hosoi discussed a study of the 1946 tsunami in Asakawa Village, Japan using a numerical model.

There were five reports concerning both instrumentation and historical tsunamis in the Pacific Ocean. The importance of deep ocean bottom pressure recorders (BPR) was emphasized in the analysis by F. Gonzalez, E. Bernard, and M. Eble of three small tsunamis generated from 17 November 1987 to 6 March 1988 in the Gulf of Alaska and recorded by a network of three BPRs, as well as by the usual tide gauge stations. The BPR network was able to provide essential information for tsunami analysis and is also an extremely useful tool for validating numerical models on propagation and run-up. Future uses of this instrument were presented in the poster session (see Figure 1). First results of an analysis of the 1985 Chilean tsunami were presented by G. Hebenstreit. Auto- and cross-correlations of the wave time series, recorded by six tide gauges north of the source area, show the three northern stations acting as a separate system, while the three southern stations respond independently. These results will be used to guide numerical simulations of the Chilean shelf as a system, rather than as individual embayments.

A new algorithm for automated tsunami warning based on the mantle magnitude, M_m (calculated from the Rayleigh wave in the 50-300 period range) was shown to be simple and fairly adequate for operational use in French Polynesia (D.Reymond, O. Hyvernaud, and J. Talandier). The role of historical research of past events in establishing present and future threat was emphasized by the analysis by A. An and S. Chun of high-tide records along the Korean coast for a period covering the last six centuries. A catalog of the tsunamis recorded in the last 25 years in

Mexico was presented by A. Sanchez and S. Farreras and shown to be a fundamental tool for hazard studies. Complimentary tools for hazard assessment, such as the research on historical tools and the study of land use vulnerability, were also illustrated. The depth and variety of papers in this session is an indicator of the growing awareness of the constraints on the research community caused by the relative scarcity of observational data.

Tsunami Hazard Mitigation

Assuming the use of the Izutani-Hirasawa method for rapid estimation of fault parameters, F. Inamura and N. Shuto showed that a slight change in the fault orientation may change the wave energy ray direction from shoreward to open seaward, resulting in a maximum error of 60% in run-up predictions. This result is important for the accuracy of predictions based on numerical simulations used by the tsunami warning systems, even for near-field tsunamis.

T.S. Murty and N.K. Saxena considered the tsunami vulnerability of some small islands inside the Exclusive Economic Zone (EEZ) of the USA in the Pacific in view of some major earthquakes predicted to occur in various seismic gaps. They discussed the importance of frequent errors in the computation of tsunami paths and travel times, which may affect the predictions of tsunami warning systems. The main sources of these errors are: use of improper chart projections, lack of consideration of rotational effects, and improper depiction of undulating sea bottom topography.

T.J. Sokolowski, P.M. Whitemore, and W.J. Jorgensen explained the implementation of a new microcomputer system in the Alaska Tsunami Warning Center. This system is used for both automatic real-time earthquake processing and interactive reprocessing-dissemi-

nation of critical information to the users. The Center continually receives and processes seismic data from 26 short-period and 6 long-period sites in Alaska and other USA States and automatically determines source parameters, making the information available in tens of seconds after the P-wave arrivals. Selected data and parameters are concurrently available to the interactive system for recomputation, dissemination of information and procedural aids.

S. Tinti detailed his first attempt to develop statistics for a total of 154 tsunamis that affected Italy from the years 1770 to 1908, with earthquakes, landslides, volcanoes and other sources. For this purpose, Italy is regionalized in 8 zones. His main goal is to evaluate probabilities of recurrence for the major events. The main difficulty in accomplishing this goal is the incompleteness of a seismic instrument network in the Mediterranean Basin. He recommends the creation of a Regional and National Warning Center in Italy. This study is important because the tsunami hazard along the Italian coasts has been substantially neglected for a long time, and Italy is one of the Mediterranean regions most affected by tsunami activity.

Two presentations were made on the testing of a satellite-linked early tsunami warning system (Project THRUST) in Valparaiso, Chile. E. Bernard showed high reliability (90%) and fast response times (87 sec) of the system over the past 3 years of testing. He reported on improvements in satellite operations that will reduce the response time to approximately 20 seconds, making this technology appropriate for other rapid onset natural disasters. E. Lorca reported on the development of the standard operations plan for the THRUST Project, including the results of a disaster exercise. The exercise exposed some deficiencies in the present plan which will be corrected.

V. Karstrevko presented a model of tsunami run-up using probability theory. Applying the theory to tsunami run-up in the USSR yielded recurrence curves of specific run-ups. J. Talandier presented the results of recent research to automate the direction, location and sizing of earthquakes in French Polynesia. He urged the use of seismic moment as the indicator of tsunami potential rather than Richter Scale magnitude. I. Tikhonov reported on plans to develop an automated system to locate and size earthquakes in the USSR using a 3-component long-period seismometer. G. Hebenstreit and J. Preuss described a study to integrate tsunami modeling and land use patterns to estimate both wave-based threat and secondary effects (fire, chemical dispersion, etc.) in a specific locality.

The papers in this session probably reflect better than any other the maturing thought process in the tsunami community. The local issues – warning, mitigation, preparedness – are gradually gaining prominence as focal points for continuing study.

Following the symposium, a team of session chairmen nominated 20 of these 65 oral presentations to be published in a special issue of *Natural Hazard* devoted to the International Tsunami Symposium. Extended abstracts of all the presentations are available from V.K. Gusiakov, Computing Center, Novosibirsk, 630090, USSR.

This contribution was prepared by E.N. Bernard, National Oceanic and Atmospheric Administration (USA) and G.T. Hebenstreit, Science Applications International Corporation (USA), who gratefully acknowledge the input by Session Chairmen A. Alexseev, F. Gonzalez, K. Kajiura, N. Shuto, T. Murty, Y. Tsuji, A. Marchuk, H. Watanabe and S. Ferreras.

Design for Real Time Reporting of Tsunamis in the Deep Ocean and Continental Shelves

H.B. Milburn, E.N. Bernard and F.I. Gonzalez

Estimates of tsunami wave amplitudes and predictions of the potential impact on endangered coastlines can be enhanced with near real time information on the oceanic characteristics of tsunamis. The concept presented here can be located in the deep ocean (2000 - 5000 m) and a complementary design is

suitable for continental shelf locations. In concept, the tsunami sensor measures low amplitude pressure waves, transmits coded information acoustically to a surface buoy and relays the data via geostationary satellite within two minutes of threshold detection.

SUBSURFACE UNIT

The subsurface unit would operate autonomously and ideally remain on the sea floor for five or more years. This will minimize support costs and improve sensor performance. (Strain elements would not be subjected to frequent reversals in forces.) The sensor electronics, microprocessors and data telemetry

systems would be designed around low power technology. A high energy density battery system with a long shelf life would be used. Energy considerations would restrict the quantity and rate at which data would be sent to the surface near real time.

Sensors

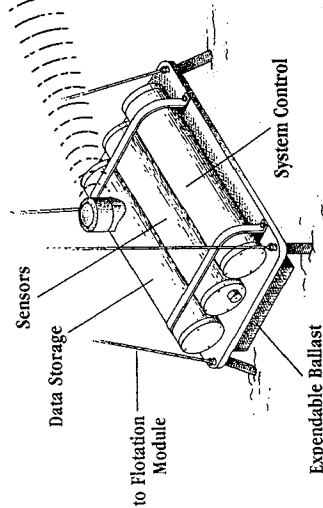
The primary element of the system is the capability to detect the passage of very small long period waves from an observation point on the seafloor. Piezoelectric gauges, which have been successfully used in similar applications, would be incorporated. To estimate sensor drift, two or more gauges would be employed.

Acoustic Telemetry

Retrieving data from the seafloor has traditionally utilized internally recording instruments and costly and time consuming recovery from ships. Alternatives to this have been several successful demonstrations of acoustic links, but high costs and great complexity of the systems have kept these tools out of the hands of most researchers and operational systems. Significantly, however, the proposed system would not be designed to carry a signal to the surface but to a transducer suspended at depth. The minimal attenuation encountered in the deep ocean and the

reduction of multipath problems from the surface reflections will allow low power communications over distances of several kilometers in the range of 14 to 22 kHz. Compressed data messages can be sent quickly at relatively low data rates. Several options on format exist and commercial efforts are underway that could lead to near off-the-shelf acoustic modems applicable for this project. Two way communications would be used to provide verification capabilities.

with one sensor providing data averaged over 15 second periods with a resolution of 1 mm of seawater. Additional gauges could be scanned at less frequent, power saving intervals to evaluate long term trends in the data. Ambient temperature would also be recorded.



Acoustic Telemetry

Data Storage

Due to the limited data that would normally be sent via the satellite link, additional data should be made available via other means. Options include dumping acoustically on command to a surface ship, retrieval of the entire subsurface package, or ejection of individual data modules on command which would float to the surface for recovery.

System Control

Expendable Ballast



BUOY / MOORING

Proven mooring technology would be used which incorporates a surface following float with a single point taut line mooring with a compliant member or a slack mooring with a reverse catenary, as shown. Small torroidal fiberglass buoys, which have been used for many years, are a cost effective platform. With a net displacement of only 2500 kg, a careful balance must be maintained between the mooring line and the forces of nature. Computer modeling aids in mooring design and has been used to optimize particular parameters.

Tsunami Data Telemetry

The NOAA GOES satellite data telemetry link would be utilized for alert messages that result from events detected on the seafloor. Experience with the random reporting feature of the system has demonstrated the ability to transmit a brief message within 2 minutes with a probability of completion of 95%. Redundant transmissions are used to increase the probability of a message being received to greater than 98% within 4 minutes. Short encoded messages would be used to minimize data transmissions for events. Additional data could be transmitted during self-timed transmissions. Continental shelf moorings could use low cost VHF telemetry links for two-way communications when moored within nominal line-of-sight distances to shoreside facilities.

Buoy Sensors

The presence of a surface buoy in remote ocean areas should be used for routine monitoring of wind speed, air temperature, sea surface temperature, barometric pressure and other parameters as needed. Such data can easily be transmitted at synoptic periods via geostationary or polar orbiting satellites. The ATLAS array in the equatorial Pacific is an example of this capability employed on a wide scale using the ARGOS system.

Electro / Mechanical Cable

Again, proven technology would be incorporated to pass electrical conductors from the buoy to a depth of 500 meters below the surface on deep ocean moorings. The cable would carry the data signals from an acoustic hydrophone set suspended at some depth below the thermocline and could support additional conductors for temperature, conductivity, or other sensors.

System Control

Data acquisition and decision making would be handled by a resident microprocessor that would be programmed with site specific algorithms. Real time processing would evaluate all incoming data to determine if any observed changes in pressure were the result of seismic action (P-wave) or long period waves in the tsunami frequency range. If an event is detected, a message would be generated and sent via the acoustic telemetry system.

Acoustic Release

NOAA / Pacific Marine Environmental Laboratory
Seattle, Washington USA

Fig. 1.

**SECOND INTERNATIONAL IOC
WORKSHOP ON THE TECHNICAL
ASPECTS OF TSUNAMI WARNING
SYSTEMS, TSUNAMI ANALYSIS,
PREPAREDNESS, OBSERVATION,
AND INSTRUMENTATION,
NOVOSIBIRSK, USSR,
4-5 AUGUST 1989**

*George Pararas-Carayannis,
International Tsunami Information Center*

Background

During the past sessions of the International Co-ordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU), great emphasis was placed on the educational program on tsunamis and the training of officials of ICG/ITSU member countries. This need was further emphasized by the United Nations' declaration of the next decade as the International Decade of Natural Disaster Reduction (IDNDR).

Tsunami is one of the major disasters that threatens the coastal populations of the world oceans and inland seas. The Tsunami Warning System in the Pacific (TWS) has been a major effort spearheaded by the Intergovernmental Oceanographic Commission (IOC) and its International Co-ordination Group for the Tsunami Warning System in the Pacific to mitigate the effects of the tsunami disaster. The Tsunami Warning System in the Pacific has been in existence since 1965. However, a great deal of progress has been made in the last few years on instrumentation, communications, and computer applications, which have had, or could have, great impact on the improvement of the Tsunami Warning System. The state of the art is rapidly changing. Even experts in the field have to review from time to time progress that is being made in technology to familiarize themselves with new concepts and learn to apply these concepts into operational tech-

niques that can result in better tsunami analysis, prediction, and communications. Improvements can be obtained in data collection and rapid processing of data as well as in prediction of tsunami heights and inundation by applying the new technology and new instrumentation to gather, process, and analyze data. Therefore, a real need was identified to have workshops and training sessions, even for the experts, during which instruction and information can be given on new technological advancements, information concerning computer circuitry, data transmission techniques, data collection, and calibration techniques and communications. Training of officials involved in the Tsunami Warning System is an important part of the overall educational requirements of ITSU member countries because these officials are, in turn, responsible for operational improvements in their own countries and for a program of general public education.

As early as August 1983, the IOC Secretariat called a special meeting in Paris, which included the Chairman of ICG/ITSU and the Director of the International Tsunami Information Center (ITIC), to review the educational needs of ITSU members. Suggestions were made that tsunami workshops should be held under the auspices of the TEMA program, that a plan for a workshop should be drafted, and that appropriate experts should be designated for such training. ITIC was charged with the responsibility of developing a curriculum and locating instructors. It was also suggested that such a workshop could be held consecutively to the ITSU and IUGG sessions so as to maximize participation and minimize cost.

On the basis of these suggestions, ITIC, in close consultation with the IOC Secretariat and the Chairman of ICG/ITSU, developed a curriculum for the training of such officials and for familiarization of participants in the

TWS, not only with conceptual improvements that have been made, but with the inner workings of the TWS, including computer applications, on-line processing, and numerical modeling. Thus, the first IOC-sponsored Workshop on the Technical Aspects of Tsunami Analyses, Prediction and Communications, was held at Sidney, B.C., Canada, on 29-31 July 1985, prior to the ITSU-X Meeting, and prior to the IUGG Conference in nearby Victoria.

Four years have since elapsed, and in this time interval, the technology has greatly changed. This second Workshop on the Technical Aspects of Tsunami Warning Systems, Tsunami Analysis, Preparedness, Observation, and Instrumentation was held on 4-5 August 1989 at Novosibirsk, USSR. The purpose of this second Workshop was to bridge the gap of four years of independent developments in the TWS and to bring together tsunami specialists from different countries to improve their knowledge of the tsunami phenomenon and to help find practical solutions to the improvement of TWS for the mitigation of the tsunami hazard. As with the first Workshop, the second Workshop was held right after the IUGG Tsunami Conference and just prior to the XII Session of ICG/ITSU. The Workshop was part of the overall TSUNAMI 89 Conference and was held in the modern and attractive research town of Akademgorodok, which is located 20 km south from downtown Novosibirsk, the capital of Siberia, in a pine-tree forest growing along the bank of the Ob River. The USSR Academy of Sciences and the Computing Center of its Siberian Division hosted the TSUNAMI 89 Conference and this second Workshop.

A Report containing the summary of the proceedings of this Workshop, as well as Annexes containing the Workshop Program, the Recommendations and a List of Participants will be published by UNESCO-IOC in

the near future in its Workshop Report Series. The full text of papers presented at this Workshop will be published by UNESCO-IOC as a Supplement to the Summary Workshop Report.

The reader is referred to these UNESCO-IOC reports for detailed accounts of the Workshop proceedings. The following summary provides only the highlights and major conclusions and recommendations of the Workshop.

Workshop Summary

The Workshop on the Technical Aspects of Tsunami Warning Systems, Tsunami Analysis, Preparedness, Observation, and Instrumentation was opened at the Dom Uchenyh Hall at the scientific town of Akademgorodok, Novosibirsk, USSR, on 4 August 1989, at 9:00 am.

Dr. Kazuhiro Kitazawa, Assistant Secretary of the Intergovernmental Oceanographic Commission (IOC) opened the Workshop, and speaking on behalf of the IOC Secretariat, extended to the participants of the Workshop a very warm welcome. Next, Mr. Hagemeyer, Chairman of the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU), speaking on behalf of the Member States of the Group, extended to the participants a very warm welcome and wished all success in achieving the objectives of the Workshop.

Dr. George Pararas-Carayannis, Director of the International Tsunami Information Center (ITIC), was nominated and subsequently elected as Chairman. Mr. Tom Sokolowski (USA) was designated as Rapporteur of the Workshop.

Dr. Pararas-Carayannis welcomed participants and briefly reviewed the beneficial exchange of views and concepts between participants at the first International Workshop which took place in Sidney, B.C., Canada, on

29-31 July 1985. The Chairman explained that the main idea of the Workshop is to bring together as many tsunami specialists from different countries as possible, and expressed the need to continue this exchange of views leading to better understanding of the practical needs for the mitigation of the tsunami hazard. He emphasized that this can be accomplished only with improved tsunami warning systems, better understanding of the latest scientific results for tsunami evaluation and prediction, and through a program of tsunami preparedness and public education. Then, he explained the rationale for the formulation of the Workshop program and the need by participants to review not only the tsunami threat in the Pacific Ocean, but in other world oceans and inland seas. Furthermore, he emphasized the need for Workshop participants to review their knowledge and information on existing seismic data processing systems, on data bases, latest developments on instrumentation, and on future projects, which may have practical application for tsunami disaster mitigation. The Chairman stated that tsunami disaster mitigation measures should be implemented, keeping in mind the objectives of the International Decade on Natural Disaster Reduction (IDNDR), a recent United Nations initiative.

A total of 28 presentations were made during the Workshop. The major subjects covered were the following:

1. International Cooperation in the Field of Tsunami Research and Warning
2. Survey of Existing Tsunami Warning Centers - Present Status, Results of Work, Plans for Future Development
3. Survey of Some Existing Seismic Data Processing Systems and Future Projects

4. Methods of Fast Evaluation of Tsunami Potential and Perspectives of their Implementation
5. Tsunami Data Bases
6. Tsunami Instrumentation and Observation
7. Tsunami Preparedness

Annex I provides the complete programme of the Workshop and the individual subjects covered. Following these presentations, recommendations were drafted and a general discussion ensued. The first recommendation addressed the need for cooperation between IUGG/Tsunami Commission and IOC/ITSU. The second recommendation dealt with the need for cooperation between ITSU and the Federation of Digital Broadband Seismograph Networks (FDSN) and outlined the expected benefits. The final recommendation addressed the need for tsunami warning systems in other areas of the globe in addition to the Pacific. After thorough discussion and deliberation, the final recommendations were prepared and adopted by the Group (Annex II). These recommendations were presented subsequently to the IUGG Tsunami Commission and to the ICG/ITSU Session and were discussed further in their agenda.

In conclusion, the second International IOC Tsunami Workshop was an overwhelming success. There were many valuable contributions that should result in material benefits to the International Tsunami Warning System in the Pacific and to the formation of regional tsunami warning systems in other vulnerable areas of the globe. Also, the Workshop brought into better focus the actions needed for implementation of the International Decade of Natural Disaster Reduction in dealing with the tsunami disaster. The Intergovernmental Oceanographic Commission (IOC), through its sponsorship, and the USSR Academy of Sciences' Computing Centers,

through hosting and coordinating local arrangements, contributed greatly to the success of the Workshop.

International Tsunami Information Center

VISITING SCIENTISTS COMPLETE TRAINING

As of March 19, 1990, Mr. Bartolome Bautista and Mr. Hernan Vergara, from the Philippines and Chile respectively, completed a 4-week Visiting Scientist Training Program at ITIC, and PTWC. The training these visiting scientists received was comprehensive, encompassing all operational aspect of the Tsunami Warning System. In addition, the visiting scientists had a thorough introduction on all aspects of the tsunami problem, and worked on specific problems related to tsunami warning in their own country and on improvements of communications.

The ITIC training program has been very successful, and has been made possible through the generous financial support of the Intergovernmental Oceanographic Commission.

PLANNING FOR SURF 90

Mr. Minoru Watanabe, head of an independent consulting firm in urban planning visited ITIC earlier this year for the purpose of collecting information for an open pavilion dedicated to the theme of tsunami, at the planned Marine Expo for 1990, called "Surf 90." Mr. Watanabe coordinated his visit with the Director of ITIC. A filming crew, visited and photographed the facilities at ITIC and at

the Pacific Tsunami Warning Center. An exhibit will be prepared for the Tsunami Pavilion of the Marine Expo, in Tokyo.

COORDINATION WITH CSIRO

At the 1989 South Pacific Forum in Tarawa, the Prime Minister of Australia announced that Australia would fund a core project over the next five years to monitor aspects of climatic change, related to the Greenhouse Effect. The total cost of this project was estimated at \$6.25 million.

This commitment was made following a feasibility study completed in May 1989 by the Commonwealth Scientific and Industrial Research Organization (CSIRO) through its Australian Marine Science and Technology Project Office (AMSAT) on behalf of the Australian International Development Assistance Bureau (AIDAB).

The feasibility study recommended that one station be established in each of Cook Islands, Fiji, Kiribati, Marshall Islands, Nauru, Papua New Guinea, Solomon Islands, Tonga,



Mr. Bartolome Bautista (philippines) and Mr. Hernan Vergara (Chile) pose with Chairman ITSU, Mr. Richard Hagemeyer and Director ITIC, Dr. George Pararas-Carayannis following presentation of diplomas for completion of the ITIC Visiting Scientists program. L. to R.: H. Hagemeyer, B. Bautista, H. Vergara, G. Pararas-Carayannis

Tuvalu, Vanuatu, and Western Samoa. An agreement is being sought from the Governments concerned for their participation in the project.

AMSAT has been retained to undertake the design stage of the project, and during the next two months a design team of three people will visit the countries concerned to identify suitable sites for the installation of sea level monitoring devices. This will involve site inspections and discussions with relevant local organizations.

As part of the overall project, Professor Geoff Lennon, who heads the study, visited Honolulu for a second time on 19 February 1990 on behalf of AIDAB to discuss relevant issues ensuring compatibility of the project with other environment and natural resource projects of a regional nature in the Pacific and compatibility with international meteorological and sea level monitoring systems.

While in Honolulu, Professor Lennon visited with Mr. Richard Hagemeyer, ICG/ITSU Chairman and Dr. George Pararas-Carayannis, Director of ITIC, and was informed of national and international efforts for sea level moni-

toring in the South Pacific in support of national regional Tsunami Warning Centers.

NHK VISIT

A television crew of NHK Japan Broadcasting Corporation, led by Program Director, Mr. Nobu-Yuki Sakanaka, visited ITIC on April 26 and interviewed extensively, Dr. G. Pararas-Carayannis, Director of ITIC, on tsunami protection methods in Hawaii, and particularly, for the city of Hilo. NHK is preparing a special television program in which certain analogies are shown on effects of tsunami disaster in Hilo, Hawaii and in Sendai, Japan. Sendai is a coastal city which has been extensively damaged by tsunamis, and particularly, by the 1960 Chilean tsunami. Since 1960 extensive seawalls have been constructed along the vulnerable coastal areas of Sendai to protect its population. Unfortunately, since 1960, and without proper planning, development has taken place along the coastal areas outside these protective walls. It is feared, and justifiably so, that a future tsunami could be devastating to such developments and will result in great loss of life. Authorities in Japan

have been unable to convince inhabitants in this danger areas of the need to relocate. It is hoped that this special NHK television program, by drawing analogies between Hawaii and Japan on their respective tsunami vulnerabilities, will have a positive impact on the population in the danger zones and will emphasize the need for improved tsunami preparedness in Sendai and elsewhere. Following the filming and ITIC interview, the NHK crew visited the Pacific Tsunami Warning Center (PTWC) and completed its filming and interviews with Mr. Gordon Burton and the rest of the staff. ITIC provided NHK with videotapes depicting tsunami experiments and tsunami effects for possible inclusion in the NHK program.



Recent ITIC visitors from USSR - Dr. Yuri Yevtodiev and Dr. Alexander Poplavsky with Dr. G. Pararas-Carayannis and his son, George, at Honolulu Airport.

- IOC/ITSU -

LIST OF NATIONAL CONTACTS OF ICG/ITSU

The following is a list of National Contacts of ITSU members on file at the ITIC office. Please inform ITIC if there are any changes.

AUSTRALIA

Mr. P. F. Noar
Assistant Director (Services)
Bureau of Meteorology
GPO Box 1289 K
Melbourne, Victoria 3001
Australia

CANADA

Mr. W. J. Rapatz
Regional Tidal Superintendent
Institute of Ocean Sciences
Dept. of Fisheries and Oceans
P.O. Box 6000
Sidney, B. C. V8L 4B2, Canada

CHILE

Captain Rodolfo Camacho Olivares
Director
Instituto Hidrografico de la Armada
Casilla 324
Valparaiso, Chile

CHINA

Mr. Luo Yuru
Director
National Bureau of Oceanography of the
People's Republic of China
Beijing, China

COLOMBIA

Commander Ricardo Alvarado
Secretario General
Comision Colombiana de Oceanografia
Apartado Aereo No. 28466
Bogota, D.E., Colombia

COOK ISLANDS

Commissioner H. R. Melrose
Police National Headquarters
P.O. Box 101
Rarotonga, Cook Islands

ECUADOR

Calm. Fernando Alfaro Echeverria
Director
Instituto Oceanografico de la Armada
Casilla 5940
Guayaquil, Ecuador

FIJI

Mr. A. Rahiman
Director, Mineral Development
Mineral Resources Department
Private Mail Bag
Suva, Fiji

FRANCE

Dr. Jacques Talandier
Directeur
Laboratoire de Geophysique
B.P. 640
Papeete, Tahiti (Polynesie Francaise) France

GUATEMALA

Ing. Eddy Hardie Sanchez Benett
Instituto Nacional de Sismologia
Vulcanologia,
Meteorologia e Hidrologia,
Ministerio de Comunicaciones
Transporte y Obras Publicas
7a Avenida 14-57 Zona 13
Guatemala, C.A.

INDONESIA

Head
Meteorology & Geophysical Agency
Dept. of Communication
Jl. Arief Rachman Hakim No. 3
P.O. Box 3540 jkt
Jakarta 10340, Indonesia

JAPAN

Dr. Toshio Akiyama
Head, Earthquake and Tsunami
Observation Division
Japan Meteorological Agency
1-3-4, Ote-machi,
Chiyoda-ku
Tokyo, Japan 100

KOREA (DPR OF KOREA)

Mr. Jong Young Gu
National Oceanographic Commission
Hydrometeorological Service
P.O. Box 100
Pyongyang
Democratic People's Republic of Korea

KOREA (REPUBLIC OF)

Mr. Sang-jo Kim
Korea Meteorological Service
1 Songwol-dong, Chongno-gu
Seoul 110-101, Korea

MEXICO

Lic. Ma de los Angeles Lopez-Ortega
Ministro Consejero
Encargada de Negocios a.i.

UNESCO

Delegacion Permanente de Mexico
1, Rue Miollis
75732 Paris, France

NEW ZEALAND

Mr. Edward Latter
Director of Civil Defence
Ministry of Civil Defence
P.O. Box 5010
Wellington, New Zealand

PERU

Contralmirante Jorge A. del Aguila Sanchez
Direccion de Hidrografia y Navegacion de
la Marina
Casilla Postal No. 80
Gamarra No. 500
Chucuito, Callao, Peru

PHILIPPINES

Mr. Conrado M. Santos
OIC, Oceanographic Surveys Div.
National Mapping Resource
Information Authority
421 Barraca St., San Nicolas
Manila, Philippines

SINGAPORE

Mr. Paul Lo Su Siew
Director
Meteorological Service Singapore
P.O. Box 8
Singapore Changi Airport
Singapore 9181, Republic of Singapore

THAILAND

Lt. Sukit Yensung
Meteorology Department
Ministry of Communication
612 Sukumvit
Bangkok 10110, Thailand

UNITED KINGDOM

Mr. Patrick P. Sham
Royal Observatory,
134A Nathan Road
Kowloon, Hong Kong

USA

Mr. Richard H. Hagemeyer
Director
National Weather Service, Pacific Region
Box 50027
Honolulu, Hawaii 96850-4993, USA

USSR

Dr. B. P. Khimitch
Chief, Arctic and Antarctic Department
USSR State Committee for
Hydrometeorology
12, Pavlik Morozov Per.
Moscow 123376
USSR

WESTERN SAMOA

The Superintendent
Apia Observatory
Private Mail Bag
Apia, Western Samoa

Director, ITIC

Dr. George Pararas-Carayannis
International Tsunami Information Center
Box 50027
Honolulu, Hawaii 96850-4993, USA

Chairman, ICG/ITSU

Mr. Richard H. Hagemeyer
Director
National Weather Service, Pacific Region
Box 50027
Honolulu, Hawaii 96850-4993, USA

ITSU XII SUMMARY REPORT

In January 1990, the Intergovernmental Oceanographic Commission published and circulated the Summary Report of the Twelfth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, which took place in Novosibirsk, USSR, 7-10 August 1989. The document was printed in English, French, Spanish and Russian, except for the annexes, which appear in English only. For copies of this document write to: Intergovernmental Oceanographic Commission, UNESCO, 7 Place de Fontenoy, 75700 Paris, France.

**SUMMARY REPORT OF
INTERNATIONAL TSUNAMI
WORKSHOP**

The Intergovernmental Oceanographic Commission is in the process of printing and distributing the Summary Report of the 2nd International Workshop on the Technical Aspects of the Tsunami Warning System (Novosibirsk, USSR, 4-5 August 1989). The IOC Workshop Report No. 58 was compiled and edited by the Workshop Chairman,

Dr G. Pararas-Carayannis, who is editing presently the proceedings of the Workshop to be published in the near future as a supplement to IOC Workshop Summary Report.

**IUGG/TC - ICG/ITSU AD HOC
WORKING GROUP ON TSUNAMI
DISASTER MITIGATION
HONOLULU, HAWAII,
30-31 JANUARY 1990**

The IOC International Co-ordination Group for Tsunami Warning System in the Pacific at its Twelfth Session (Novosibirsk, USSR, August 7-10, 1989) adopted the second recommendation of the workshop and proposed the establishment of a Joint IUGG Tsunami Commission-IOC/ITSU Ad Hoc Working Group of Experts on Tsunami Disaster Mitigation with the following tasks:

- formulate a project on tsunami disaster mitigation as a contribution to the
- International Decade on Natural Disaster Reduction (IDNDR)
- provide adequate advice on implementation of the project to sponsoring organizations
- seek possibilities to hold a Joint Scientific and Technical Seminar on
- mitigation of Tsunami Hazard in 1990-1991.

Mr. R. Hagemeyer, Chairman ICG/ITSU and Dr. N. Hamada of JMA were the designated two members of ITSU. Dr. E. Bernard, President, IUGG Tsunami Commission, and Academician A. Alexseev (USSR Academy of Sciences) were the two IUGG members. A session of the Ad Hoc Working Group was held in Honolulu January 30-31, 1990. Dr. A.P. Metalnikov, Dr. V.K. Gusiakov (USSR), and Dr. V. Jivago (IOC), also attended.

The results of this meeting and record of

Action are presently being reviewed by IUGG and ITSU members. The final outcome will be presented at a subsequent issue of the Newsletter.

23RD SESSION OF THE EXECUTIVE COUNCIL, PARIS, 7-14 MARCH 1990

The Executive Council of the Intergovernmental Oceanographic Commission (IOC) held its 23rd Session at the UNESCO Headquarters in Paris, 7-14 March 1990. Under agenda item 5-4, Mr. Richard Hagemeyer, Chairman of ITSU, addressed the Group and presented the Summary Report of the Twelfth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific (Novosibirsk, USSR, 4-5 August 1989, Document IOC/ITSU-XII/3), together with the results of the International Workshop on the Technical Aspects of the Tsunami Warning System (Novosibirsk, USSR, 4-5 August 1989; IOC Workshop Report No. 58).

The Executive Council considered the reports and provided directives and advice on actions proposed by the Group in the form of a resolution for the next intersessional period (1990-1991), including establishment of Tsunami Warning System in other oceanic areas and an increase in the overall support to the programme.

FIRST SESSION OF IOC'S SUB-COMMISSION FOR THE WESTERN PACIFIC (WESTPAC), HANGZHOU, PEOPLE'S REPUBLIC OF CHINA, 5-9 FEBRUARY 1990

The First Session of IOC's Sub-Commission for the Western Pacific (WESTPAC) took place at Hangzhou, People's Republic of China, on 5-9 February 1990. The Secretary of IOC, Dr. Gunnar Kullenberg, on behalf of IOC and

UNESCO, welcomed the participants and thanked the host country, People's Republic of China, for inviting and hosting this first Session. IOC through its Resolution XV-9, established the IOC Sub-Commission for the Western Pacific (WESTPAC). WESTPAC has the following terms of reference:

- (i) define regional problems, the solution of which calls for international cooperation, and promote, develop and coordinate the required marine scientific research programmes and related activities;
- (ii) implement and coordinate the regional components of global marine scientific research programmes and activities of the Commission;
- (iii) promote the development and use, at the regional level, of ocean services and related supporting activities, coordinated or maintained by the Commission;
- (iv) facilitate the exchange of scientific data and information and the transfer of knowledge resulting from marine scientific research, especially to developing countries in the region;
- (v) assist with the identification of training, education and mutual assistance needs in the region, particularly those relating to the programmes of the Sub-Commission, and promote the required TEMA activities;
- (vi) make recommendations to the governing bodies of the Commission on policy matters, and submit proposals on the budgetary and other forms of support required for the programme of work of the Sub-Commission;
- (vii) cooperate with other subsidiary bodies of the Commission on technical matters of common interest;

- (viii) provide general guidance and serve as a mechanism for Member States for the formulation, evaluation and follow-up of proposals for extra-budgetary projects aimed at strengthening national and regional capabilities in marine scientific research and the establishment of common institutions, services and facilities (e.g. centres, networks, etc.);
- (ix) cooperate with the regional subsidiary bodies of the UN organizations members of ICSPRO and of other UN organizations as well as regional bodies collaborating with the Commission;
- (x) when appropriate:
 - (a) form Task Teams to carry out specific assignments,
 - (b) establish Groups of Experts, and
 - (c) organize technical meetings (e.g., workshops), provided costs fall within the budget allocated to them or extra-budgetary funding is available for that purpose; otherwise recommendations to that effect shall be submitted to the governing bodies of the Commission for their consideration and approval.

Under Agenda item 6.2.2 (Ocean Services) the Secretary IOC introduced the International Tsunami Warning System in the Pacific (ITSU), Document IOC/SC-WESTPAC-I/2. Dr. Huating Yang, Senior Engineer, China Institute for Marine Development Strategy, of the People's Republic of China, represented ITSU at this First Session of WESTPAC and gave a report on the history and activities of the Group.

IOC SCHEDULED MEETINGS (1990)

8-10 May 1990: Washington D.C., USA. SCOR-IOC/CCCCO WOCE Scientific Steering Group Meeting - 14th session. Duration: 3 days. Responsible Organization: SCOR, IOC.

28-30 May 1990: Bremerhaven, Germany FR. Meeting of the GEBCO Scientific Committee on Digital Bathymetry (SCDB) - 7th session. Duration: 3 days. Responsible Organization: IOC, IHO.

28 May - 1 June 1990: Paris, France. Joint SCOR-IOC Committee on Climatic Changes and the Ocean(CCCO) - 11th session. Duration: 5 days. Responsible Organization: SCOR, IOC.

May 1990: Leningrad, USSR. Meeting on Experts on Sea Level Measurements in the Antarctica. Responsible Organization: IOC.

18-22 June 1990: Havana, Cuba. Congress on Marine Sciences - 2nd/Meeting of the Association of Marine Laboratories of the Caribbean - 23rd. Duration: 5 days. Responsible Organization: AMLC, IOC, UNESCO, UNEP.

June 1990: Bidston, UK. GLOSS Sea Level Training Course - 8th. Responsible Organization: IOC.

June 1990: Moscow, USSR. Meeting of the Central Editorial Board for the Geophysical Atlases of the Pacific and Atlantic Oceans (GAPA) - 10th. Duration: 3 days. Responsible Organization: IOC.

3-5 July 1990: Port Louis, Mauritius. Editorial Board of the International Bathymetric Chart of the Western Indian Ocean (IGCWIO)- 2nd session. Duration: 3 days. Responsible Organization: IOC.

16-20 July 1990: Honolulu, Hawaii, USA. International Tropical Oceans and Global Atmosphere (TOGA) Scientific Conference. Duration: 5 days. Responsible Organization:

WMO, ICSU, IOC, SCOR.

23-27 July 1990: Honolulu, Hawaii, USA. SCOR-IOC/CCCO TOGA Scientific Steering Group - 9th session. Duration: 5 days. Responsible Organization: SCOR, IOC, WMO, ICSU.

July 1990: Wormley, UK. Meeting of the Organizing Committee for Ocean Climate Data Workshop - 2nd. Responsible Organization: IOC. Meeting of IODE Group of Experts on RNODCs and Climate Services. Responsible Organization: IOC.

22 Aug - 2 Sep 1990: Venice, Italy. Scientific Workshop of Physical Oceanography of the Eastern Mediterranean (POEM) - 4th. Duration: 12 days. Responsible Organization: UNESCO.

18-21 Sep 1990: Monte Carlo, Monaco. IOC Consultative Group on Ocean Mapping (CGOM) - 4th session. Duration: 4 days. Responsible Organization: IOC.

Sep 1990: France. GLOSS Sea Level Training Course. Responsible Organization: IOC.

Sep/Oct 1990: Tokyo, Japan. JODC Training Course for IODE in WESTPAC - 9th. Responsible Organization: IOC, JODC (JP).

16-19 Oct 1990: Melbourne, Australia. Drifting Buoy Co-operation Panel (DBCP) - 6th session. Responsible Organization: IOC, WMO.

16-19 Oct 1990: Miami, Florida, USA. IOC Group of Experts on GLOSS - 2nd session. Duration: 5 days. Responsible Organization: IOC.

17-19 Oct 1990: Toulouse, France. SCOR-IOC WOCE Scientific Steering Group - 15th. Duration: 3 days. Responsible Organization: SCOR, IOC.

29 Oct - 4 Nov 1990: Geneva, Switzerland. World Climate Conference - 2nd. Duration:

7 days. Responsible Organization: UNESCO, UNEP, WMO, ICSU.

Nov 1990: To be arranged. Joint IOC-WMO-CPPS Working Group on the Investigations of El Nino - 7th session. Responsible Organization: IOC, WMO, CPPS.

Dec 1990: Geneva, Switzerland. Joint WMO-IOC Intergovernmental TOGA Board (ITB) - 4th session. Responsible Organization: WMO, IOC.

1990: To be arranged. Jakarta, Indonesia. Workshop on Sea Level Rise. Responsible Organization: UNESCO.

Jan/Mar 1991 (tentative): Paris, France. IOC Committee for Training, Education and Mutual Assistance (TEMA) - 5th session. Duration: 11 days. Responsible Organization: IOC.

National and Area Reports

TSUNAMI RISK ASSESSMENT FOR AUSTRALIA

The Australian Seismological Centre of the Bureau of Mineral Resources is undertaking a tsunami risk assessment for Australia. Although Australia is not a high risk area for tsunamis, the neighboring Solomon Islands and Papua New Guinea are more susceptible to locally-generated tsunamis.

The most recent event in the region was a strong earthquake measuring over 8 on the Richter scale which occurred on May 23, 1989, at the Macquarie Ridge, 250 km north of Macquarie Island. A 0.3 m tsunami was recorded along the southern coast of Tasmania and a 2 cm tsunami was observed on the east coast at Sydney.

TSUNAMI RISK IN CHINA

The National Marine Environmental Forecasting Center in Beijing reports that the tsunami risk in China derives from seismic activity in the Taiwan seismic zone and the South China Sea, and from earthquakes from other countries such as Japan, the Philippines and Indonesia.

About 6 percent of earthquakes occurring in coastal areas or offshore generate tsunamis. China is thus threatened by the tsunami hazard, although the occurrence is not frequent.

CHILE: DISASTER PROGRAM FORMALLY APPROVED

According to the Newsletter "Disaster Preparedness in the Americas," the Emergency Preparedness Program of Chile's Ministry of Health has completed a three-year phase (December 1986-89) of promotion and development activities. In January, 1990, the Ministry of Health passed a resolution officially approving the Program. For a copy of the Program's background, purpose and objectives write Dr. Guillermo F. Quiroz Elissalt, Programa Nacional de Preparativos para Emergencias y Control de Desastres, Ministerio de Salud, Monjitas y MacIver, Santiago, Chile.

COLOMBIA DISASTER EDUCATION

According to "Disaster Preparedness in the Americas," the deans of faculties of medicine and public health met in Bogotá to strengthen the commitment of all of Colombia's universities to include disaster preparedness in their curricula. Four Colombian universities have assumed a regional leadership role in teaching health sector disaster management concepts. In addition, more than half of the other universities have included the subject in the curricula of schools of medicine and public health. The University of Antioquia, a WHO Collaborating Center, is coordinating a

regional survey of the undergraduate and postgraduate academic courses offered in disaster preparedness in institutions in South America. For further information write to Dr. John Florez, Universidad de Antioquia, A.A. 1226, Medellín, Colombia.

TSUNAMI RISK IN MEXICO

Estaciones de Investigaciones Oceanograficas and CICESE Research Center of Mexico state that Mexico's West Coast is especially vulnerable to the tsunami hazard. Local earthquakes have generated the most destructive tsunamis in the past, while distant tsunamis have been a lesser threat. In the Baja California-Gulf distant tsunami are the most likely danger, whereas in the Central-South local ones are predominant. In the Central Guerrero, Ometepe-San Marcos and Central Oaxaca, local tsunami pose the greatest threat.

A HISTORY OF TSUNAMIS IN THE U.S. PUBLISHED

The National Geophysical Data Center in Boulder, Colorado, has published a 265 page report entitled "United States Tsunamis (Including United States Possessions) 1690-1988." Written by James F. Lander and Patricia A Lockridge, the book documents tsunami occurrences throughout recorded history for the United States and its territories.

The text is very informative and illustrated with graphics, maps and photographs. Send orders to the National Geophysical Data Center, 325 Broadway, E/GCI, Department 753, Boulder, CO 80303-3328. Telephone: (303) 497-6337. Hardcover costs \$30, softcover \$15. An additional \$10 is required for handling inside the U.S. and \$20 for orders from outside the U.S. Payment should be made to the National Geophysical Data Center, NOAA.

USE OF THE Mm MAGNITUDE FOR TSUNAMI DETERMINATION

Following on the action items resulting from the ITSU XII meeting in Novosibirsk, USSR, in August 1989, Dr. J. Talandier, Director of the Geophysical Laboratory in French Polynesia provided ITIC with a copy of the program listing and the associated files on the use of the Mm Magnitude for tsunami determination. As discussed in Novosibirsk, Dr. Talandier will share the software with the different countries of the ITSU Group and the software will be distributed by ITIC. This software is now available.

The Director of ITIC has requested Dr. Talandier to provide either the Mm magnitude calculation software for distribution as 1600 BPI tape written in ASCII and/or a 3 1/2 or 5 1/4 compatible floppy disk.

CHANGE TO THE COMMUNICATION PLAN FOR THE TSUNAMI WARNING SYSTEM

On 15 January 1990, the US National Weather Service, Pacific Region distributed to all holders of the Communication Plan for the Tsunami Warning System, Change 3 to the Communication Plan, Eleventh Edition, dated December 1987. This change updates the information on the Communication Plan.

CYCLONE OFA DAMAGES TSUNAMI WARNING SYSTEM INSTRUMENTATION

Mr. F. Malele, Acting Superintendent of Apia Observatory in Western Samoa recently reported that Cyclone Ofa did a lot of damage to the Apia Observatory's main office building and its equipment.

Mr. Malele reported that the tide gauge 'stilling well' was broken and washed away during the damaging surges in the harbour.

Similarly, the remote recorder located in the main office building was destroyed together with the whole building. As of now, except for the visual staff at the tide gauge pier, the tide gauge proper and the tsunami instrumentation is inoperable. The whole tsunami instrumentation needs replacement. The cyclone destroyed all the records.

Presently, efforts are being made to reconstruct the Apia Observatory. Mr. Malele has taken over as Acting Superintendent since the cyclone, and has written to PTWC and ITIC for assistance in reconstructing the tsunami instrumentation at the Apia Observatory.

Announcements

SURF 90

Kanagawa Prefecture, which is located south of Tokyo, is busily planning for a Marine Expo for 1990, called "Surf 90." In the expo there will be an open air pavilion dedicated to the theme of tsunami. The proposer and planner of the pavilion, Mr. Minoru Watanabe, head of an independent consulting firm in urban planning, visited Hawaii and contacted all the agencies involved in the Tsunami Warning System.

XII WORLD CONGRESS OF SOCIOLOGY, JULY 1990, MADRID, SPAIN

At the XII World Congress of Sociology in Madrid in July, the Research Committee on Disasters will hold a session. Topics will include cross-national approaches to disaster research and planning, the mass media in disasters, and research on the IDNDR. For information, contact Russell R. Dynes, Disaster Research Center, University of Delaware, Newark, Delaware 19716.

THIRD INTERNATIONAL COURSE ON HEALTH AND DISASTER, JULY 1990

A third International Course on Health and Disasters will be held in July in Brussels co-sponsored by the Agency for Cooperation and Development, Government of Belgium, and the World Health Organization, Geneva. For information, contact the Centre for Research on the Epidemiology of Disasters, School of Public Health, University of Louvain, 30 Clos Chapelle-aux-Champs, EPID 30.34, Brussels 1200, Belgium. Telephone: (2) 764-3823/3327. Telefax: (2) 764-5322. Telex: B 23722 UCL WOL.

INTERNATIONAL CONFERENCE ON ENVIRONMENTAL MANAGEMENT OF ENCLOSED COASTAL SEAS '90, 3-6 AUGUST 1990, KOBE, JAPAN

An international conference on Environmental Management of Enclosed Coastal Seas '90 will take place from 3-6 August 1990, at Kobe, Japan. Among the session topics are Present State of Environmental Pollution at Enclosed Coastal Seas and Measures for Environmental Protection; Appropriate Use of Enclosed Coastal Seas; and Management and Administration of Enclosed Coastal Seas. For information, contact the Secretariat, EMECS '90, 10-1 Shimoyamatedori 5-chome, Chuo-ku, Kobe 650, Japan.

INTERNATIONAL WORKSHOP ON LONG-WAVE RUNUP AUGUST 15-17, 1990 LOS ANGELES, CALIFORNIA

Background

The workshop will cover all areas of long-wave runup research and practice, including numerical, analytical laboratory and field studies. Invited speakers from different countries will give one hour lectures summarizing

historical and current developments of different aspects of wave runup. Speakers whose abstracts are accepted will be invited to give fifteen minute presentations. The workshop is sponsored by a grant from the National Science Foundation of the United States and is open to all researchers around the world; there will be no registration fees. Participants are expected to cover their travel costs. However, a very limited amount of funds is available for partial reimbursements of travel expenses of invited speakers.

Objectives

It is anticipated that the workshop will review the state of the art of long-wave runup and it will help identification of areas where knowledge is fragmented and incomplete. It is expected that the workshop will help develop reciprocal technology transfer channels between theory and practice and that it will lead to suggestions for future research directions in tsunami runup hazard mitigation. The workshop will also address the issue of maintenance of numerical codes for runup predictions and the development of certain benchmarks problems for calibration and comparison.

Proceedings

A contract is currently under negotiation for the publication of selected papers from the proceedings of this workshop.

Organizing Committee

Professor Philip Liu
Hollister Hall
Cornell University
Ithaca, New York 14853
Fax (607) 255-9004
Phone (607) 255-5090

Professor Costas Synolakis
Kaprelian Hall - 2531
University of Southern California
Los Angeles, California 90089-2531
Fax (213) 749-3289

Phone (213) 743-2941

Professor Harry Yeh
Wigmore FX-10
University of Washington
Seattle, Washington 98195
Fax (206) 685-3836
Phone (206) 685-8655

Tsunami researchers interested in presenting their runup related work should submit one or two page abstracts of their planned talks by May 1, 1990 to any member of the organizing committee. Other interested participants should contact the organizing committee or the conference administrator:

Mrs. Janine Nghiem at
USC-2531
Los Angeles, California 90089-2531
(213) 743-2941

**INSMAP '90,
15-19 OCTOBER 1990,
MIAMI, FLORIDA**

The International Symposium on Marine Positioning (INSMAP'90) will be held at the Rosenstiel School of Marine & Atmospheric Science at the University of Miami, Florida, U.S.A., on October 15-19, 1990. Among the sessions and workshops are Policy, Plans, and Trends; Seafloor Positioning; GPS in Marine Positioning; Absolute Sea Level; Marine Mapping and Charting; and Tsunami Prediction and Marine Positioning. A Tsunami Session has been organized under this symposium and will be co-chaired by Dr. T.S. Murty and Mr. T. Sokolowski. The following is the tentative program for the Tsunami Session:

Pararas-Carayannis, G.

The Importance of Geodetic Parameters in the Understanding and Mitigation of the Tsunami Hazard.

Saxena, N.K.

Bathymetry and Tsunami Predictions.

Rapatz, W.J. and T.S. Murty

Observational Requirement for the Tsunami Warning System in Canada.

Sokolowski, T.

Expert System in Tsunami Hazard Mitigation.

El-Sabh, M.I., J. Chasse and T.S. Murty

Nonlinear Numerical Modelling of Tsunami Generation and Propagation in the St. Lawrence Estuary.

Tinti, S.

Tsunami Hazards in the Mediterranean Sea.

Kowalik, Z. and T.S. Murty

Relevance of Bathymetry for Tsunami Run-up Modelling.

For more information on INSMAP'90, write to:

Dr. George A. Mau
AOML, Physical Oceanography Division
4301 Rickenbacker Causeway
Miami, Florida 33149, U.S.A.
(Fax No. (305) 361-4449).

**XTH WORLD CIVIL DEFENCE
CONFERENCE
10-12 NOVEMBER 1990,
BAGHDAD, IRAQ**

At the invitation of the Government of the Republic of Iraq, the International Civil Defence Organization (ICDO), on the occasion of its IXth General Assembly, within the framework of the International Decade for Natural Disaster Reduction, will hold the Xth World Conference of Civil Defence on 10, 11 and 12 November 1990 in Baghdad, at the Babylon Karada Hotel.

The general theme of the conference is "Civil Defence and Development." The following subjects will be discussed:

1. *Civil Defence: Conceptions and Structures*

- definition, tasks and responsibilities of States and of relevant non-governmental organizations

- structures and organizations of national systems of civil defence.

2. *Economic Aspects of Catastrophes*

- catastrophes: economic costs and impact on development programs
- planning of emergency measures and integration in national plans of development.

3. *Civil Defence at International Level - Cooperation*

- prevention, assistance and relief
- international humanitarian law, civil defence law - international conventions and treaties.

The working languages of the conference will be Arabic, English, French and Spanish. Simultaneous interpretation will function throughout the conference sessions.

Registration for the Xth World Conference of Civil Defence are from this moment open to all States, organizations and persons interested. All documentation relative to this conference and all other useful information will be sent to them in due course. No participation fee is required.

For further information, please apply to the Secretariat for the Xth World Conference of Civil Defence:

O.I.P.C., 10-12 chemin de Surville
1213 Petit-Lancy
(Geneva) Switzerland.
Cable Procivint-Geneve CH
Telephone: (41 22) 793.44.33
fax: (41 22) 793.44.28
telex 423.786 CH.

**INTERNATIONAL SYMPOSIUM ON
GEOPHYSICAL HAZARDS IN
DEVELOPING COUNTRIES AND
THEIR ENVIRONMENTAL IMPACTS
21-27 APRIL 1991
CAIRO, EGYPT**

An international symposium on Geophysical Hazards in Developing Countries and their Environmental Impacts will be held on April 21-27, 1991, in Cairo, Egypt.

This international symposium is the fourth in the continuing interdisciplinary series begun in 1982, with the first being held in Honolulu, USA. The second one was held in Rimouski, Canada in 1986 and the third meeting in Ensenada, Mexico during 1988. The objectives of this series of symposia on natural and man-made hazards are to promote the advancement of hazard sciences, to perceive and explore those aspects that may be similar among some of the various hazards, to review the newest developments in a few selected fields, and also to outline new directions for future research.

Under the umbrella of HAZARDS'91, several symposia and workshops will be held, dealing with all aspects of natural and technological disasters, with particular emphasis on those occurring in developing countries. Keynote speakers, special invited lectures and contributed papers on current practices and research activities will be grouped into the following themes:

Cyclones and other severe weather systems
Storm surges and their coastal effects
Tsunami generation and propagation
Biotoxins and other marine natural hazards
Air and water pollution
Floods and droughts

Ice-related hazards

Earthquakes, landslides and snow avalanches

Soil erosion

Deforestation and desertification

Climatic changes and their impacts

Risk assessment problems

Preparedness, mitigation and management

The IDNDR: a perfect chance to put hazard research into practice

The International Society for the Prevention and Mitigation of Natural Hazards (NHS) is the principal scientific organization sponsoring HAZARDS'91. The meeting is co-sponsored by the following organizations:

The Tsunami Society

The International Association for the Physical Sciences of the Oceans (IAPSO)

IAPSO Commission of Marine Natural Hazards

Academy of Scientific Research and Technology, Egypt

International Tsunami Information Center

Other organizations wishing to be considered for sponsorship should contact either Dr. T.S. Murty, chairman of the Scientific Committee or Dr. Mohammed I. El-Sabh, chairman of the Organizing Committee.

Call for Papers

The Organizing Committee invites all scientists, engineers and policy makers involved in natural and technological hazards to participate actively in HAZARDS'91. Authors are invited to submit extended abstracts of 2-3 pages (up to 40 lines per page). To maintain a high scientific standard, it is thought that extended abstracts will help in a better

screening of the submitted papers. Original and two copies of the extended abstracts should be sent to the chairman of the Scientific Committee, Dr. T.S. Murty before July 31, 1990. Camera-ready abstracts should be typed on 216 x 270 mm paper with 25 mm margins. Spacing between lines should be 1.5 mm. Elite 12 type is preferred. The heading block should include the following items on successive lines (i) the title in capital letters, and (ii) the name(s) of the author(s) in upper and lower case letters, and affiliation. There should be two-line space between the heading block and the text. All lines including the title, names and text are to be typed left-justified. A volume of the extended abstracts will be pre-published and will be made available to the participants prior to the meeting. Full papers should reach the coordinator by December 31, 1990. All manuscripts will go through careful and full editorial standards and only good quality papers will be included in the final proceedings of the Symposium to be published in a special issue of Natural Hazards.

Location

The venue of HAZARDS'91 is Cairo, Egypt, which has all the necessary facilities to host this international gathering. Apart from its well known history, Egypt has been exposed to several disasters such as floods, drought, storm surges, earthquakes, landslides, soil erosion, desertification, air and water pollution. The meeting comes at a time of the year when the weather is very pleasant. Cairo is connected by air to all major international cities. A wide variety of hotel space is available starting with economic two-star hotels to luxury five-star hotels. Combining the scientific meetings with family holidays is recommended.

A second circular containing registration, housing, transportation and detailed description of field trips and social activities will be

issued in late May 1990. All correspondence relating to the meeting should be addressed to either one of the following:

Dr. T.S. Murty
Chairman,
International Scientific Committee
HAZARDS'91
c/o Institute of Ocean Sciences
P.O. Box 6000
Sidney, B.C., Canada V8L 4B2
Telephone: (604) 356-6311
Telefax: (604) 356-6390
Telex: 04-97281
Telemail: IOS.BC

or

Professor Mohammed I. El-Sabh
Chairman,
Organizing Committee
HAZARDS'91
Department d'Océanographie
Université du Québec à Rimouski
300 Allée des Ursulines
Rimouski, Quebec, Canada G5L 3A1
Telephone: (418) 724-1707
Telefax: (418) 723-7234
Telex: 051-31623

For further information and in order to receive the second circular, please write to either Dr. T.S. Murty, Chairman of the International Scientific Committee, or to Professor M.I. El-Sabh, Chairman of the Organizing Committee.

XVII PACIFIC SCIENCE CONGRESS MAY 27 - JUNE 2, 1991

The Pacific Science Association will hold the XVII Pacific Science Congress in Honolulu, Hawaii on May 27-June 2, 1991.

The theme is "*Towards the Pacific Century: The Challenge of Change*." This international, inter-disciplinary meeting is sponsored by the University of Hawaii, the East-West Center

and the Bishop Museum in cooperation with the U.S. National Academy of Sciences.

Scientists, scholars, administrators, government officials and members of the business community who are interested in issues which affect the peoples and environments of the Pacific are encouraged to attend. Individuals wishing to organize sessions or organizations interested in holding meetings in association with the Congress should contact the Congress Secretariat immediately.

All correspondence should be addressed to:

XVII Pacific Science Congress Secretariat
2424 Maile Way, Fourth Floor
Honolulu, HI 96822 USA
PHONE - (808) 948-7551
TELEX - 6504047720
FAX - (808) 942-9008
BITNET - psc@uhccux.bitnet
Dr. Nancy Davis Lewis, Secretary General
Linda Pearsall, Congress Manager

Topics

In addition to the traditional focus on research, this Congress will address policy issues and the application of science to regional problems. The title of the Congress and its six themes are:

*Towards the Pacific Century:
The Challenge of Change*

Global Environmental Change—Pacific Aspects

Population, Health and Social Change
Science and Culture

Biological Diversity

Technologies for Development: Perspectives for the 21st Century

Dynamics of the Earth and the Heavens:
The Pacific Arena

Contributed papers and poster presentations will also be organized into general sessions which will complement the Congress

themes. The nineteen Scientific Committees of the Pacific Science Association have been invited to develop sessions reflecting their topic of interest. The Scientific Committees are: Agricultural Sciences; Botany; Coral Reefs; Ecology, Conservation and Environmental Protection; Economics; Entomology; Forestry; Freshwater Sciences; Geography; Information Sciences and Technology; Marine Sciences; Material Sciences and Technology; Meteorology and Atmospheric Sciences; Museums and Similar Institutions; Nutrition; Public Health and Medical Sciences; Science Communication and Education; Social Sciences and Humanities; and Solid Earth Sciences.

The program of the XVII PSC will include invited paper sessions, plenary speakers, general sessions and poster sessions. Opportunities are also available for round-table and panel discussions.

Scientific Excursions, Field Trips

Scientific excursions will be held before, during and after the Congress in the Hawaiian Islands and in one or more Pacific countries. These will focus on particular topics and will provide participants opportunities to visit relevant sites with experts. In addition, field trips of a more general nature will be held.

XX GENERAL ASSEMBLY OF THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS, 11-24 AUGUST 1991, VIENNA, AUSTRIA

The Austrian National Committee of Geodesy and Geophysics announced that it is hosting the XX General Assembly of the International Union of Geodesy and Geophysics in Vienna from 11 to 24 August. There will be interdisciplinary symposia, workshops, general sessions and poster pre-

sentations. A science theatre will feature geoscience films and an exhibition geoscience products.

SYMPOSIUM ON TSUNAMI DISASTER REDUCTION VIENNA, AUSTRIA, 19 AUGUST 1991

The Tsunami Commission's 15th International Tsunami Symposium will focus on research that leads to disaster reduction. The 1-day symposium will emphasize tsunami observation, physical processes of tsunami evolution, and hazard reduction through assessment techniques and warning systems.

Researchers are invited to send abstracts to the convenor:

Dr. E.N. Bernard
Chairman
Tsunami Commission, NOAA/PMEL
Bldg. 3-Bin C15700
7600 Sand Point Way N.E.
Seattle, WA 98115-0070 USA
FAX (206) 526-6815.

WORLD MAP OF VOLCANOES, EARTHQUAKE, AND PLATE TECTONICS

A map showing volcanoes, earthquakes and plate tectonics has been jointly published by the U.S. Geological Survey and the Smithsonian Institution. Volcanoes that have been active during the past 10,000 years are plotted from the Volcano reference File of the Smithsonian Institution, along with epicentres of selected large earthquakes since 1897 and from instrumentally recorded earthquakes from 1960 to the present.

Copies of the map can be obtained from the

U.S. Geological Survey

Map Distribution, Federal Center
Box 25286
Denver, CO 80225
Telephone: (303) 236 -7477

The cost is \$3, plus \$1 for handling.

NEW NHS NEWSLETTER

The International Society for the Prevention and Mitigation of Natural Hazards has published its first issue of its newsletter "NHS Newsletter." For information, contact:

S. Venkatesh
Natural hazards Society
c/o Environmental Prediction Research Station, Atmospheric Environment Service
4905 Dufferin Street
Downview, Ontario, Canada M3H 5TA.
Telephone: (416) 739-4911
Telefax: (416) 739-4521
Telex: 06-964582.

VIDEO ON NATURAL DISASTERS AVAILABLE IN JAPANESE

The video "*Myths and Realities of Natural Disaster*," produced in 1987, has been seen by people in Latin America, the Caribbean, the United States, Canada, and Europe. Now it is available in Japanese and can be obtained through:

Dr. T. Ukai
Senri Critical Care Medical Center
1-1 Tsukumodai, Suite 565
Osaka, Japan

or

Disaster Relief Division
Japan International Cooperation Agency
Mitsui Building
1-1 Nishishinjuku 2-Chome
Shinjuku-ku, Tokyo 163, Japan.

Pacific Tsunami Warning Center

COMPUTERS UPGRADED AND DATA SYSTEMS ADDED TO THE PACIFIC TSUNAMI WARNING CENTER

The Pacific Tsunami Warning Center (PTWC) converted its operations from a Data General minicomputer to a new Masscomp/Concurrent 6000 computer system. The new system is well suited for acquiring and analyzing seismic and tide data and interfacing with various communications systems to disseminate critical warning products to users around the Pacific Rim. It also now has operational access to 24 of the new Next Generation Water Level Measurement System Platforms deployed by NOAA's National Ocean Service.

TESTING TSUNAMI DATA TRANSMISSION USING JMA'S SATELLITE

Following Dr. N. Hamada's visit to Hawaii and the Pacific Tsunami Warning Center (PTWC) earlier this year, a test transmission was set up on 23 February 1990 utilizing JMA and GTS satellites. According to Dr. Hamada, Head of the Earthquake and Tsunami Observation Division of JMA, all the test transmissions were satisfactory. Data was transmitted from the Handar Data Collection Platform (DCP) in tsunami gage in Honolulu, to JMA in Tokyo via GTS satellite. More testing of such data transmissions was made in the later part of March. This could be a major enhancement in the transmission of tsunami data from DCP and tsunami gages in the western Pacific which are out of reach of the present GOES satellite.

PTWC EXTENDS SEA LEVEL NETWORK

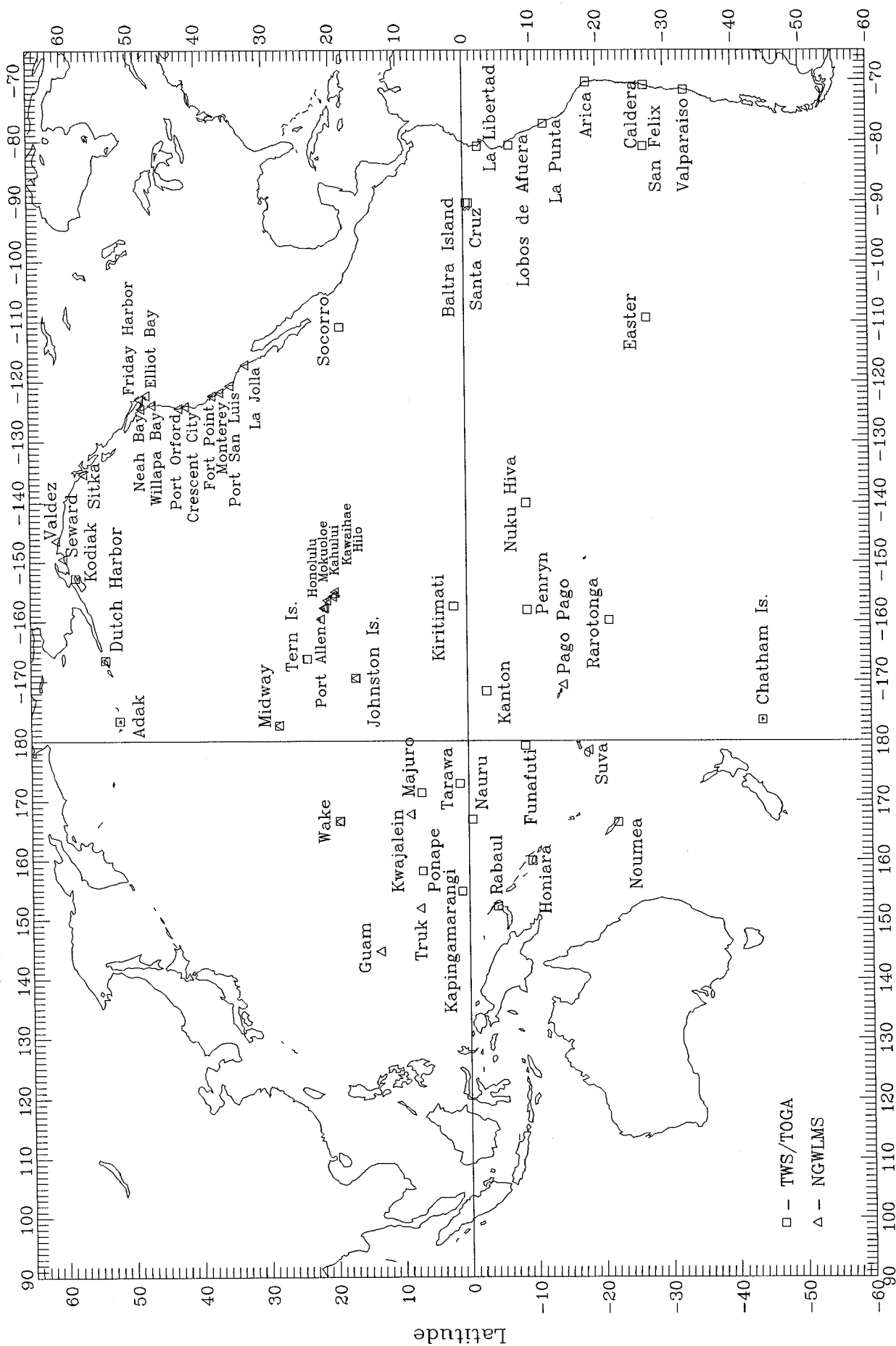
The Pacific Satellite Sea Level Network has been developed through the coordinated efforts of the Pacific Tsunami Warning Center (PTWC) and the TOGA Sea Level Center at the University of Hawaii. Using the Data Collection Platform technology, manufactured by Handar Corporation, 32 DCP's have been deployed around the Pacific Basin.

With the installation of the new Concurrent 6600 minicomputer at PTWC, additional capabilities have become possible. The National Ocean Service (NOS) is continuing deployment of their Next Generation Water Level Measurement System (NGWLMS), which also uses GOES for satellite data communications. However, unlike the Handar DCP, the NGWLMS is programmed to transmit sea level data in a packed binary format. PTWC and the TOGA Sea Level Center have not been successful in efforts to unpack the

NGWLMS data using microcomputers, but with the capability of the new 6600, this obstacle has been overcome. This has enabled PTWC to receive sea level data from 26 NGWLMS units presently operating in the Pacific. This provides much needed coverage along the West Coast of the United States and extended coverage in Alaska, Hawaii, and the Western Pacific.

Sea level data from these combined 58 DCP's are being relayed automatically to PTWC within 3-5 minutes of transmission. Data are being logged directly by the new 6600 minicomputer for archiving and processing as required. PTWC staff have developed computer software to build separate data files for each remote station and display graphical sea level plots within 2 minutes. PTWC now has the operational capability to detect and monitor tsunami activity within minutes at any or all of the stations comprising the Pacific Satellite Sea Level Network.

Pacific Satellite Sea Level Network



Longitude

Tsunami Reports

MARIANA TRENCH TSUNAMI - APRIL 5, 1990

Origin: 2113Z - April 5, 1990

Epicenter: Lat. 15.4 N, Long. 147.3 W

Magnitude: 7.4 (Ms)

Location: Mariana Trench, 70 nm East of Saipan

Near-Source Reports:

The Office of Civil Defense, Saipan, reported no tsunami damage at Saipan or Tinian. Based on an inspection trip around the island of Saipan, no tsunami activity was reported. Tinian reported observable tsunami activity at the dock, but no damage. News reports received from Guam of 3-4 meter waves at Tinian and Saipan were considered by Saipan Civil Defense to be greatly exaggerated.

Pacific Satellite Sea Level Network (PSSLN):

The following activity was observed by PSSLN:

Adak, Alaska	Negative
Arica, Chile	Negative
Baltra Island, Galapagos	Negative
Caldera, Chile	Negative
Crescent City, California	Negative
Chatham Island, New Zealand	Negative
Christmas Island, Kiribati	Negative
Dutch Harbor, Alaska	Negative
Easter Island, Chile	Negative
Elliott Bay, Washington	Negative
Fort Point, California	Negative
French Frigate Shoals	Negative
Friday Harbor, Washington	Negative
Funafuti, Tuvalu	Negative
Guam	Negative
Hilo, Hawaii	Negative
Honiara, Guadalcanal	Negative
Honolulu, Hawaii	Negative
Johnston Island	Negative
Kahului, Hawaii	Negative
Kanton Island	Negative

Kapingamarangi	Negative
Kawaihae, Hawaii	Negative
Kodiak, Alaska	Negative
Kwajalein	Negative
La Jolla, California	Negative
La Libertad, Ecuador	Negative
La Punta, Peru	Negative
Lobos de Afuera, Peru	Negative
Majuro, Marshall Islands	Negative
Midway	Maximum height 0006 cm by 0225Z on 06 April; initial wave arrival at 0215Z with 0004 cm drop; period 12-14 minutes.
Mokuoloe, Hawaii	Negative
Monterey, California	Negative
Nauru	Negative
Neah Bay, Washington	Negative
Noumea, New Caledonia	Negative
Nuku Hiva, Marquesas	Negative
Pago Pago, American Samoa	Negative
Penryn	Negative
Pohnpei, FSM	Negative
Port Allen, Hawaii	Negative
Port Orford, Oregon	Negative
Port San Luis, California	Negative
Rabaul, New Britain	No data
Rarotonga, Cook Islands	Negative
San Felix, Chile	Negative
Santa Cruz, Galapagos	Negative
Seward, Alaska	Negative
Sitka, Alaska	No data
Socorro, Mexico	No data
Suva, Fiji	Negative
Tarawa, Gilbert Islands	Negative
Truk	Maximum height 0003 cm by 2315Z; initial wave arrival at 2235Z 05 April; period 12 minutes.
Valdez, Alaska	Negative

Valparaiso, Chile	Negative
Wake Island	Maximum height 0004 cm by 0015Z 06 April; initial wave arrival at 2345Z 05 April; period 12 minutes.
Willapa Bay, Washington	Negative

Hawaii Regional Tsunami Warning Network:

Hilo	Negative
Honolulu	Negative
Honuaipo	Negative
Kapoho	Negative
Kahului	Negative
Kailua-Kona	Initial wave arrival on 06 April at 0553Z with 0010 cm oscillations; maximum height of 0024 cm at 0736Z; period 5 minutes.
Mahukona	Negative
Puuloa	Negative

Reports Received from JMA:

Choshi	Maximum height 0006 cm by 0218Z
Mera	Maximum height 0016 cm by 0311Z
Yaene	Maximum height 0019 cm by 0203Z
Chichijima	Maximum height 0023 cm by 0021Z
Uchiura	Maximum height 0004 cm by 0311Z
Owase	Maximum height 0007 cm by 0146Z
Kushimoto	Maximum height 0015 cm by 0241Z
Murotomisaki	Maximum height 0024 cm by 0140Z
Tosashimizu	Maximum height 0022 cm by 0156Z
Hyugashirahama	Maximum height 0004 cm by 0215Z
Aburatsu	Maximum height 0010 cm by 0226Z
Naha	Maximum height 0004 cm by 0207Z

Seismic Summary

OCTOBER 1989 TO PRESS TIME

1989-13	Oct 18 0004Z 6.9	San Francisco area 37.0N 122.0W	Tsunami information bulletin issued
1989-14	Oct 27 2105Z 7.1	Solomon Islands 10.4S 162.6E	Tsunami information bulletin issued
1989-15	Nov 01 1826Z 7.3	East of Northern Honshu, Japan 39.7N 141.7E	Tsunami information bulletin issued
1989-16	Nov 15 1844Z 7.2	Mindanao, Philippines 09.1N 126.9E	Tsunami information bulletin issued
1989-17	Dec 30 2319Z 6.5	Papua New Guinea 03.7N 145.1E	Tsunami information bulletin issued
1990-1	Mar 03 1216Z 7.5	Fiji Basin 22.8S 175.4E	Tsunami information bulletin issued
1990-2	Mar 05 1638Z 7.1	Vanuatu 18.5S 167.1E	Tsunami information bulletin issued
1990-3	Mar 25 1323Z 6.8	Costa Rica 10.6N 085.2W	Tsunami information bulletin issued
1990-4	Apr 05 2113Z 7.5	230 miles northeast of Guam 15.4N 147.3E	Tsunami information bulletin issued

July 1990

1990-5

Apr 18
1340Z
7.5

Sulawesi, Indonesia
02.8N
123.5E

Tsunami information bulletin
issued

ANNEX I

PROGRAMME OF THE WORKSHOP

1. OPENING OF THE WORKSHOP
2. INTERNATIONAL COOPERATION IN THE FIELD OF TSUNAMI RESEARCH AND WARNING
 - 2.1 International Cooperation in the Field of Tsunami Research and Warning, (G. Pararas-Carayannis)
3. SURVEY OF EXISTING TSUNAMI WARNING CENTERS - PRESENT STATUS, RESULTS OF WORK, PLANS FOR FUTURE DEVELOPMENT
 - 3.1 Pacific Tsunami Warning Center (G. Burton)
 - 3.2 Hawaii Regional Tsunami Warning System (G. Burton)
 - 3.3 Alaska Regional Tsunami Warning Center (T. Sokolowski)
 - 3.4 Japan Tsunami Warning Center (N. Hamada)
 - 3.5 USSR Tsunami Warning Center (B. Kuznetsov)
 - 3.6 French Polynesia Tsunami Warning Center (J. Talandier)
 - 3.7 Chile Tsunami Warning Center (E. Lorca)
 - 3.8 Tsunami Watches and Warnings in Fiji (G. Prasad)
 - 3.9 Assessment and Mitigation of the Tsunami Hazard in the Mediterranean Area (S. Tinti)
4. SURVEY OF SOME EXISTING SEISMIC DATA PROCESSING SYSTEMS AND FUTURE PROJECTS
 - 4.1 Operative Seismic Data Processing in the NEIC and Plans for the New US National Seismic Network (J. Dewey)
 - 4.2 POSEIDON Project - its Application to the Better Understanding of Nature of the Interplate Earthquakes (R. Geller)
5. METHODS OF FAST EVALUATION OF TSUNAMI POTENTIAL AND PERSPECTIVES OF THEIR IMPLEMENTATION
 - 5.1 A Review of Earthquake Prediction Methods (G. Pararas-Carayannis)
 - 5.2 Mm: A Variable-Period Mantle Magnitude (J. Talandier, E. Okal)
 - 5.3 On Earthquake Tsunami Generation Criteria (A. Ivashchenko, A. Poplavsky, S. Soloviev)
 - 5.4 The Feasibility of Measuring the Low Frequency T Phase for Tsunami Warnings (S Iwasaki)
 - 5.5 Application of New Numerical Methods for Near-Real Time Tsunami Height Prediction

(V. Gusiakov, An. Marchuk, V. Titov)

5.6 The Goal and Efficiency of the Automated Tsunami Warning System Project in the Far East of the USSR (I. Kuzminykh, M. Malyshev, A. Metainkov)

5.7 Integrated Warning System for Tsunami and Storm Surges in China (H. Yang)

6. TSUNAMI DATA BASES

6.1 An Automated Tsunami Catalog. (A. Bobkov, C. Go, N. Zhigulina, K. Simonov)

6.2 Tsunami Data Base for British Columbia Tsunami Warnings. (T. Murty, W. Rapatz.)

6.3 Historical Approach to the Study of Tsunamis: Recent U.S. Results. (J. Lander.)

6.4 The Development of Numerical Simulation of Tsunami Waves at the Computing Center at Krasnoyarsk (Yu. Shokin, L. Chubarov, V. Novikov, A. Sudakov, K. Simonov)

7. TSUNAMI INSTRUMENTATION AND OBSERVATION

7.1 A Long-term Deep Ocean Tsunami Measurement Program: Strategy and Instrumentation (F. Gonzalez, E. Bernard, H. Milburn, D. Mattens)

7.2 Tsunami Observations Using Ocean Bottom Pressure Gauge (M. Okada, M. Katsumata)

7.3 Offshore Tsunami Warning Station - MEGA (G. Rybin)

7.4 Re-Use Plan of Commercial Submarine Communication Cable for Geophysical Research (J. Kasahara)

8. TSUNAMI PREPAREDNESS

8.1 Tsunamis of the 21st Century (G. Pararas-Carayannis)

9. GENERAL DISCUSSION AND ADOPTION OF RECOMMENDATIONS

10. CLOSURE OF THE SESSION

ANNEX II

WORKSHOP RECOMMENDATIONS

Recommendation 1

CO-OPERATION BETWEEN IUGG/Tsunami COMMISSION AND IOC/ITSU

The Workshop,

Recognized that the majority of tsunami damages to human community occurs within 30 minutes and 400 kms of its source;

Recognized further that sufficient scientific knowledge and technical expertise is currently available to develop appropriate early tsunami warning systems;

However, recognized also that many difficulties exist both in transferring scientific results to operational procedures and in communicating operational requirements to research communities;

Considered the objectives of the UN International Decade on Natural Disaster Reduction (IDNDR) and the need for international and interdisciplinary co-operation in mitigation of tsunami hazards;

Recommends that an ad hoc Joint IUGG/Tsunami Commission - IOC/ITSU Group of Experts be formulated with objectives of:

- (i) formulating a project on tsunami disaster mitigation as a contribution to the International Decade on Natural Disaster Reduction;
- (ii) providing adequate advice on implementation of the project to both sponsoring organizations;

Recommends also that IUGG and IOC seek possibility to hold a Joint Scientific and Technical Seminar on Mitigation of Tsunami Hazard in 1990/91.

Recommendation 2

THE NEED FOR CO-OPERATION BETWEEN ITSU AND THE FEDERATION OF DIGITAL BROADBAND SEISMOGRAPH NETWORKS (FDSN)

1. BACKGROUND

- (a) The tsunami community now recognizes the importance of broadband, wide-dynamic range seismic waveform data for issuing tsunami warnings. The tsunami community is therefore moving rapidly to establish real-time seismic networks.
- (b) The international earthquake seismology community has established a consensus on the

importance of broadband, wide-dynamic range seismic waveform data for studying: (i) the three dimensional distribution of elastic and anelastic properties of the earth's interior; and (ii) the details of the earthquake source process. Through IASPEI, the earthquake seismology community has established the FDSN for the purpose of (1) establishing standards for broadband seismic stations; (2) establishing formats and procedures for data exchange; and (3) co-ordinating the plans of various networks to avoid unnecessary duplication of effort.

- (c) In general the members of ITSU have excellent liaison with earthquake seismologists in their own country. However, on an international level, at present, there is no formal liaison between ITSU and FDSN.

2. RECOMMENDATIONS

- (a) Formal liaison between ITSU and FDSN should be established.
- (b) When seismic stations are being established by ITSU Member States in support of Tsunami Warning Systems, FDSN Members should, whenever possible, be advised of this fact so that they may have the opportunity to investigate the feasibility of upgrading the stations to meet FDSN standards for broadband stations. *

3. EXPECTED BENEFITS

- (a) Both FDSN and ITSU will obviously benefit if the above recommendations are implemented.
- (b) A real-time seismic network for tsunami warning also is a real-time network that permits accurate and almost instantaneous determination of the source parameters of all damaging earthquakes, anywhere in the world. This obviously is of tremendous importance for disaster relief authorities, and can greatly contribute to the goals of IDNDR.

** Even if limitations on telemetry do not permit the transmission of the full bandwidth, the broadband data should be recorded on tape and sent to the data center rather than being discarded.*

Recommendation 3

TSUNAMI WARNING SYSTEMS IN OTHER REGIONS

Considering that tsunamis have occurred in the past in areas of the globe other than the Pacific also,

Considering that some of these tsunamis were reported to be highly disastrous resulting in great property damage and considerable catastrophic life loss,

Considering that growing world population, increasing urban concentration and larger investment in the infrastructure of societies are taken place nowadays particularly along the coastal regions and are expected to grow in the future,

Considering the important role played by ITSU towards international co-operation in tsunami research and tsunami warning systems,

Considering the important experience and achievement gained by actual ITSU member states and the needs to transfer such experience to other countries concerned with tsunami hazards.

It is recommended that ITSU strongly urge the IOC to encourage the establishment of organizations similar to ITSU to address the needs of other tsunami-prone areas and to offer ITSU technical advice to these new organizations to facilitate their establishment and the development of Tsunami Warning Centers within their area of responsibility.x